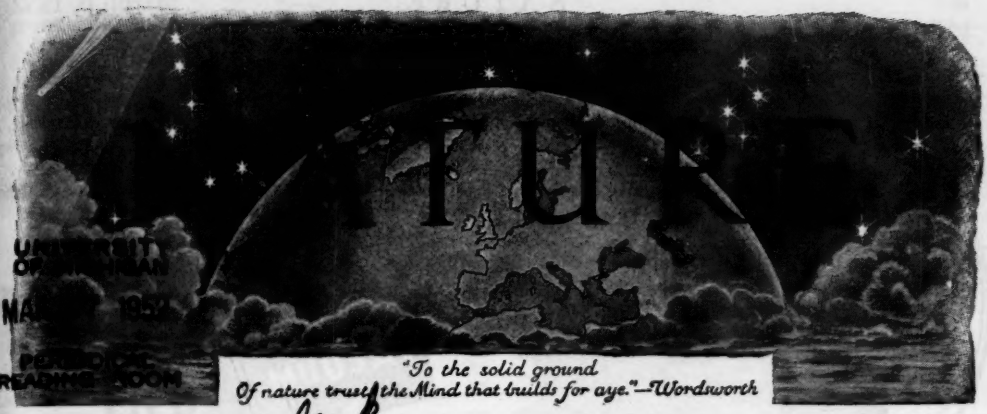

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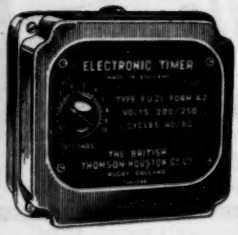

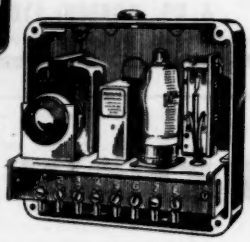

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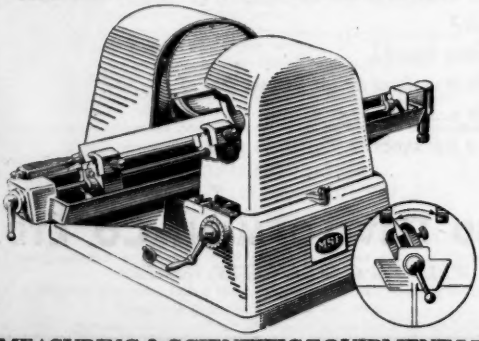

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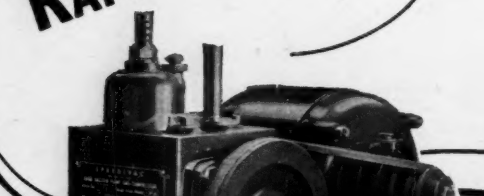

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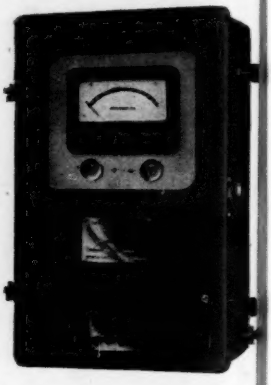

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FREEDOM OF INFORMATION

A PAPER entitled "Official History: its Pitfalls and Criteria", originally published by Prof. H. Butterfield in June 1949, and included in a revised form in his book "History and Human Relations" last year, will repay study by anyone who has occasion to write or to discuss the history of science or technology. It also indicates exactly why and how the new Bill to amend the law of defamation which Mr. Harold Lever has presented to Parliament concerns the scientific worker. "Of all the principles which touch the life of States and peoples," writes Prof. Butterfield, "it seems to me that the most important in the secular sphere is the one which insists upon freedom of thought", by which he means freedom in the expression of thought and freedom of a minority to attempt to convert the majority. "Under the shelter of this general principle, there will exist (when the body politic is healthy) an independent science of history, not hostile to the government but standing over against it—a science which will seek to present the cause of historical truth as distinct from the things which might be promulgated from motives of *raison d'État* or for the sake of a public advantage or in order to cover the imprudences of politicians and government servants."

Repeated instances in recent years have shown the importance of full freedom of comment in public affairs, and especially where scientific and technical questions are involved. If the man of science or technologist does not enjoy such freedom of comment and criticism, above all on what are matters of fact, his association in the task of government will be hindered. This is not simply a matter of the hypersensitivity of Ministers or of Civil servants to responsible expert criticism, though there have been sufficient examples of such behaviour to justify Prof. Butterfield's suggestion that our predecessors recognized better than we do that an independent science of history always tends to find the dice loaded against itself for the time being. It is difficult for men to place truth above public advantage when public advantage might mean the winning of a war, the circumvention of a diplomatic crisis, the covering of a reputation, or even an improvement in general welfare. In times of stress, it is easy to feel that the historian should serve the government.

Quite apart from the illustrations he provides in support of this thesis, Prof. Butterfield's essay is worth reading for its reminder that causes may be lost by unconscious compliances and complicities, and its warning of the danger that freedom can easily be allowed to slide away. Concessions, apparently innocuous, when made to people whom we happen to like and trust, become at the next remove the ground from which a new generation of men can make a more serious encroachment on liberty. We need to remember much more constantly that freedom is always a matter of struggle and vigilance.

In so far as freedom of information is concerned, the secrecy issue has in the past ten years brought most scientific workers to realize what is at stake for

the advance of science. That is only a part of the field, however; comment and criticism are another aspect. The detailed recommendations of the Porter Committee on the law of libel were largely directed towards the provision of further protection for the responsible dissemination of facts and opinions in the public interest. Such a measure is, in fact, an essential part of the review, long overdue, of the whole structure of government, including such matters as the organisation and control of the nationalized industries now being investigated by the Acton Society Trust as well as by a Select Committee of the House of Commons, and the examination of such questions as delegated legislation and publicity for local government matters as well as for those of the central government.

The private member's Bill now introduced by Mr. Lever merely attempts to translate into legislative form the more important proposals of the Porter Committee. It deals simply with actionable defamation and attempts to correct the restraints upon free discussion which the recognized principles have come in practice to involve, though without exposing anyone's deserved reputation to new dangers. Those principles are simple enough: the truth may always be stated in speech or in print, but comment must be fair and in the public interest; it must not be malicious, and if such comment is founded upon a misstatement, it is *ipso facto* unfair. In practice, however, the protection due to truth may be forfeited because some minor detail of the statement cannot be proved. Meanings may be imputed to comment which are remote from the writer's intention; and both statement and comment may have been taken to affect the reputation of persons to whom they only apply accidentally.

A technical periodical, equally with a newspaper, may be vulnerable because it reports a public utterance which afterwards proves to be untrue or malicious, and, in view of the risk of falling foul of some mere technicality of the law, the press is naturally cautious. Facts or arguments that should in the public interest be brought forward and made known tend in consequence to be disguised or concealed. In such conditions the effective participation of the technical expert in public affairs can be seriously hampered, and Mr. Lever's Bill should rightly be viewed as an ancillary means of promoting the fuller association of knowledge with government or power. It provides that, where defamation has been unintentional, public correction and apology is made the normal and sufficient remedy, without the payment of financial compensation. The plea of justification, that is, the offer to prove the statements of fact, is not to fail by reason of some trivial error. The press is given a new and clearer list of cases in which a fair and accurate report of the utterances of others is protected or privileged.

The list applies to newspapers; but it is clear that the scientific and technical press is also concerned. For example, such periodicals frequently wish to print reports of proceedings in public of a body or person appointed to hold a public inquiry by a government, or a court notice or advertisement, and they should be privileged to publish such statements without explanation or contradiction. It is also customary for the scientific and technical press to publish reports of the findings of associations in Great Britain and elsewhere which exist to promote, for example, art, science and learning, and have power over the professional conduct of their members. It is only right that such periodicals should enjoy the same privilege of statement, subject to explanation or contradiction, concerning anyone who is a member of such an association or subject to its control, that is proposed for the newspaper press.

Many journalists appear to hold the view that the recommendations of Lord Porter's Committee do not go far enough. The proposals in Mr. Harold Lever's Bill, to which the Attorney-General has already promised some support, should do something to remove the handicaps in performing its public duties from which the British press suffers from the law of libel as it has come to be interpreted. The man of science can only welcome the greater freedom in the exposure of abuses which the new Bill will make possible for the press. Its enactment should contribute something at least to the more effective utilization of knowledge in the public service, and to the defence of individual freedom from the many dangers which threaten it to-day. As Mr. Lever emphasized in moving the second reading of the Bill on February 1, it attempts once more to secure the universal principle that the public convenience is to be preferred to private interests, and accordingly communications which the interests of society require to be unfettered should be made freely by persons acting honestly and without malice. Scientific and technical factors have increasingly occurred in such matters during the past half-century, and, as Mr. Lever observed, the judges have failed to adapt the law sufficiently to the existing conditions of society.

The points raised in the debate on February 1, when the Bill received a unanimous second reading in the House of Commons, were essentially points for consideration by the standing committee to which the Bill was referred. The Attorney-General did not attempt to discuss any of the clauses in detail, but said that he believed there was room for considerable discussion and argument as to the phrasing of clause 3 relating to the form in which a correction and apology is to be published, and the absence of negligence was capable of definition in this connexion. He also attached considerable importance to some of the arguments advanced in the debate regarding clause 4, which attempts to define publication without intent to defame, and clause 11, which permits a defendant to bring evidence of the character or reputation of the plaintiff, in mitigation of damages. On the whole, the points raised in the debate appear to have been considered very carefully already by the Porter Committee, but Mr. Parker's intervention made particularly clear the way in which a research organization or a technical journal may find itself, under present conditions, unable to publish comment that is desirable in the public interest. This restraint would be removed by the Bill, and Mr. D. Weitzmann

in the debate pointed out that it is precisely the smaller periodicals and other institutions with limited resources which are at present most handicapped and obliged to exercise a severe prudence, and matters which it may be in the public interest to disclose or discuss are not revealed. On the whole, the issues were fairly stated in the debate, and sufficient goodwill was manifested on all sides to warrant the hope that a reasonable balance will be struck between the public interest in the way of information, and responsible comment and the individual right of protection against damage.

JOSIAH WILLARD GIBBS

Josiah Willard Gibbs

The History of a Great Mind. By Lynde Phelps Wheeler. Pp. xi+264+9 plates. (New Haven, Conn.: Yale University Press; London: Oxford University Press, 1951.) 25*s.* net.

THIS biography, by a pupil of Gibbs, is the first complete and critical account of his life and of the development of his work. A brief memoir by Bumstead was printed in the collected works, and other accounts have been written, which unfortunately were intended to illustrate rather distorted views of his genius. In the present work Prof. L. P. Wheeler has made full use of new material collected by the Gibbs family, particularly a collection of "Personal Recollections and Impressions of J. Willard Gibbs", which is now in the Yale University Library, and also of his surviving papers and letters. The book throws a good deal of new light on the origins of Gibbs's work and does much to put it in a proper perspective. It is interesting, though not surprising considering the American background at this time, to find that Gibbs's first studies were in practical engineering, and his Ph.D. at Yale University was the first to be awarded in the United States for engineering and the second for science as a whole. In these early years he applied himself to a projected "center-vent turbine" which did not materialize and to an improved brake for railway cars, which did receive a patent later in 1866. He also published a careful discussion of the units used in mechanics.

It was with this apparently practical bent and outlook that Gibbs went to Europe in 1866. He first visited Paris, where he injured his health by attending sixteen lectures a week—and no doubt reading all the classic memoirs of French mathematical physics. In Berlin (1867) and Heidelberg (1868–69) he learnt to moderate his studies, and also became fully acquainted with German physics teaching and methods of work, which were to provide the model for his own work. There is nothing to indicate that he had close relations with the professors whose lectures he attended; and the lecture notes which have survived are not very detailed.

There is little in this to prepare us for the classic papers on thermodynamics which appeared between 1873 and 1878. Most great scientific workers have left at least some apprentice efforts to show how their ideas germinated and how they developed. With Gibbs, on his return to Yale there is, first, an improvement of the Watt pendulum governor, then in 1873 the paper on the use of graphical methods in the thermodynamics of fluids—a paper which, though comparatively simple, was the basis of the subsequent development—and then, within a few years, the great papers on heterogeneous equilibrium which show a complete understanding of all the possibilities and how to formulate them and a complete mastery of the method and full confidence.

It would be a revealing study of human nature if one could know what went on in the mind of this quiet, unassuming and friendly man; by what process the fragmentary and ill-understood knowledge of the time was integrated into this great and enduring synthesis. Gibbs has often been praised for the thoroughness of his memoir—the fact that he explored, once and for all, nearly all the consequences of the second law of thermodynamics, so far as they can be applied to chemical equilibrium. But he himself thought otherwise in his later years. In a letter to Lord Rayleigh he said, "I thank you very much for your kind interest in my 'Equil. Het. Subs.'. I myself had come to the conclusion that the fault was that it was too *long*. I do not think I had any sense of the value of time, of my own or of others, when I wrote it". It is perhaps true that some of the relations discovered are trivial, and many concerned possibilities which have remained uninvestigated until the present day. The details certainly obscured the ready understanding of the great fundamental equations of chemical thermodynamics.

Although the memoirs were published in the rather obscure *Transactions of the Connecticut Academy*—a periodical with a small circulation—it is not true, as is sometimes stated, that Gibbs was indifferent to their recognition. He himself distributed about ninety copies of the memoirs to a list of names which included most of the best-known European physicists.

Prof. Wheeler gives a very lucid account of Gibbs's later work on optics and on statistical mechanics. In both these fields Gibbs showed the same mastery of essentials and power of synthesis as was shown in the thermodynamics. The work on optics was rather overshadowed by parallel developments in Europe[1]. The masterly nature of the work on statistical mechanics is now well recognized. Gibbs was perhaps a little unfortunate in coming just before the development of the quantum theory provided a body of experimental material to which his method could be applied, but his approach was so sound that it could accommodate the quantum theory without any difficulty. He sought a comprehensive theory embracing all physical phenomena, yet, while he was aware of the impossibility of completing such a theory, the foundations he laid have proved to be perfectly adequate. "In the present state of science," he wrote, "it seems hardly possible to form a dynamical theory of molecular action which shall embrace the phenomena of thermodynamics, of radiation and of the electrical manifestations which accompany the union of atoms. Yet any theory is obviously inadequate which does not take account of all these phenomena."

All students of the physical sciences should read this book for the deep insight it gives into the development of a mathematical description of the physical world. Edward Jenner said, "Why think?—Try the experiment". Gibbs's life may well be held to illustrate the contrary adage. No doubt both have their place, but Gibbs, more than any other man of science of his time, had a clear appreciation of where thinking was appropriate and where experiment was necessary.

J. A. V. BUTLER

[1] For a study of Gibbs's method in optics, see Wheeler, L. P., *Proc. U.S. Nat. Acad. Sci.*, **37**, 850 (1951).

CRYSTALLOGRAPHIC DATA

Structure Reports for 1947–1948

Vol. 11. A. J. C. Wilson (general editor). (Published for the International Union of Crystallography.) Pp. x+779. (Utrecht: N. V. A. Oosthoek's Uitgevers Mij., 1951.) n.p.

SCIENTIFIC workers in every sphere will benefit enormously from the recent appearance of the new volume of "Structure Reports", for in physics, chemistry, mineralogy, metallurgy and biology alike, there is already an impressive range of problems to which crystallographic techniques have been applied with advantage.

The International Union of Crystallography has wisely decided to continue the abstracting of structural data undertaken until 1939 in "Strukturbericht", so the new series will bridge the gap between 1939 and the present time, and continue to report new work as it appears. This first volume deals with 1947–48, to avoid starting with a serious time-lag.

The book, like Cæsar's Gaul, is divided into three parts—metals, inorganic compounds and organic compounds—each the responsibility of a separate team of abstractors. The arrangement within individual reports is usually (but not always) as follows: name, formula, papers reported, unit cell, space group, atomic positions and parameters, interatomic and intermolecular distances, material, discussion, details of analysis, and references—an exhaustive list which indicates the admirable thoroughness of the abstracts.

Anyone who has had much experience of the arduous and exacting task of scientific abstracting will recognize the quite exceptional care and skill which a team of busy and competent people have expended, often in time they could ill spare, on the production of a body of abstracts of unusual merit. It would be inappropriate, therefore, to criticize too freely what is undoubtedly an extremely valuable book, except in the conviction that its shortcomings lie in the planning of the work rather than in its execution; for the policy adopted, whatever its merits in theory, has obviously proved difficult to carry out in practice, and might perhaps be modified in the preparation of subsequent volumes.

First, the scope of the abstracts. "Ideally," says the introduction, "they extract only material of structural interest." However, although the depth of the quagmire into which the abstractor may plunge via the ill-defined bypaths of some "structural interest" is perhaps over-emphasized by the unusually complex problem of diamond (pp. 187–197), the close connexion between the structure and properties of all substances makes it seem imperative to decide just where to draw the line, if it is not to be drawn ruthlessly at atomic positions. No such decision would seem to have been made.

It is fair to say that no volume of this kind is better than its index, so we must be especially grateful for the provision of comprehensive subject (that is, name) and formula indexes (but why should the mixed crystals referred to on p. 687 occur in the former, but not in the latter?). There is also an author index. The strictly alphabetical arrangement of the formula index will prove particularly valuable to non-chemists. But the inclusion in the subject index of "a few physical properties" seems regrettable, because misleading. The scarcity of entries is due not only to the declared policy of abstracting "only material of structural interest", but also to inadequate indexing. To cite but three examples: "Infra-red emission" (surely "absorption" was intended; no data are quoted concerning infra-red emission) and "Raman Effect" are listed only for diamond (as are 25 per cent of all these extra entries) although the data quoted for urea (p. 596) and ammonium chloride (p. 219) seem at least equally interesting; and under "Texture" there is no reference to divergent-beam photography (p. 748).

Secondly, it is stated that this volume covers the period 1947–48. Almost one-quarter of the main entries in the inorganic section (and about a dozen of those in each of the other sections) cite publications outside this period. One can understand the temptation to include work published prior to 1947 if later work on the substance is entirely dependent on it, but the inclusion of, for example, $N_2H_4F_2$ (p. 267) or $KSbO_3$ (p. 443), published in 1942 and 1940 respectively, does not seem justified merely for comparison with more recent work. Why would a reference not have been sufficient? Apart from the fact that this increased scope must lead either to extensive duplication in future volumes, or to the exclusion of work from the volume to which it really belongs, there is no clear indication as to whether or not any work has, in fact, been done in the period 1940–46 on substances for which the period 1947–48 has not been overstepped. If the abstractors have consistently covered this wider period, surely this fact should be indicated in the title.

The book is well produced in clear type, and illustrated by some two hundred informative line diagrams. Although there are a number of misprints, these are seldom likely to cause confusion; but if, and when, it becomes necessary, perhaps a list of errata could be published in *Acta Crystallographica*.

These criticisms notwithstanding, we will all wish to associate ourselves with Prof. P. P. Ewald (who as the initiator of "Strukturbericht" has fittingly contributed the preface) in welcoming these excellent abstracts.

H. J. Grenville-Wells

INDUSTRIAL TOXICOLOGY

The Chemistry of Industrial Toxicology

By Dr. Hervey B. Elkins. Pp. ix+406. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1950.) 44*s*. net.

INDUSTRIAL toxicology is an expanding subject, and Dr. Hervey B. Elkins has made a very creditable attempt to pack a vast amount of useful information into the 406 pages of his book. There are many attractive features, notably the systematic presentation and the inclusion of numerous clearly labelled diagrams, and a wide range of tables. In particular, the parallel recording of concentrations with vapour pressures of certain substances (for example, mercury, Table 6, p. 39) is a time-saving aid to a hard-worked chemist who may have to give a quick and intelligible answer to his non-technical colleagues.

It is a relief to find that the author has departed from the tedious routine of facts by including at least two controversial chapters, namely, Chapter 14, "Maximum Allowable Concentrations", and Chapter 15, "Fallacies and Unsolved Problems". The latter is a bold and happy addition and includes comments

on such current industrial problems as berylliosis and cancer resulting from chromate poisoning. Although the United States insists on hard-and-fast values for maximum allowable concentrations of toxic substances, it is as well to accept such figures with reserve. It is felt that one cannot set out as safe, concentrations lower than the recommended maximum allowable concentrations, since very prolonged exposures at the lower levels may still result in chronic symptoms.

Chapter 17, on "Analytical Methods and Procedures", is good, although some of the methods are very tedious, for example, that of Stock for mercury in urine. It is felt that a simple and more rapid method, possibly involving dithizone, would be a great deal more acceptable to the investigator who has few assistants and requires to carry out many dozens of investigations. On the whole, the methods are well set out, although it is felt that the lists of equipment and reagents should be placed before analysis.

It is also a little exasperating to find that out of the 366 representative references more than thirty are labelled "private communications"; many of these refer to items or procedures not specified, and therefore leave the user rather in the air as to what has been communicated.

Before an environmental study can be undertaken, it is usually necessary to select an appropriate air-sampling device. The author lists several of these very attractively in Chapter 16; but in view of the divergence of opinion that exists on the efficiency of such collecting devices as electrostatic precipitators, filters and impingers, one feels that a more critical guide on their relative merits and demerits would have been advantageous.

Nevertheless, the book is good; and, although its price is somewhat high to the individual, it should form a most useful library or bench reference book, for the use of all workers in industrial toxicology.

D. G. Harvey

SCIENTIFIC WORKS OF JEAN PERRIN

Oeuvres scientifiques de Jean Perrin

Pp. xii+408. (Paris: Centre National de la Recherche scientifique; London: H. K. Lewis and Co., Ltd., 1950.) 1500 francs; 33*s*.

FRENCH genius is characterized by the sudden appearance of an individual who opens up a new chapter in science in a manner which is unexcelled in both clarity and deductive logic. Such a man was Jean Perrin, and we are indebted to his son, Francis Perrin, and the Centre National de la Recherche scientifique for this collection of Perrin's scientific papers.

While Perrin's early interest lay in examining the properties of the then newly discovered electron, it was not until he commenced his studies of the Brownian agitation and its relation to molecular magnitudes that his full genius was revealed. Papers on this subject were collected and published in the now classical volume "Les Atomes". Among Perrin's other important contributions must be mentioned his investigations on the origin of charges at the surfaces of membranes immersed in an electrolyte and his work on fluorescence. In the former investigation Perrin sought to find the origin of the Helmholtz double layer which was believed to play an all-important part in the phenomenon of electric endosmosis and cataphoresis. By the simple device of utilizing packed powders as membranes, he was able to show that electric endosmosis only occurred in conducting liquids and that both surface ionic dissociation and selective ionic adsorption were responsible for the formation of the double layer and the concomitant electrical effects in electrolytic transport and also in the phenomenon of colloid coagulation. He noted, in particular, the predominating influence of both protons and hydroxyl ions, and in his papers one can see the first suggestion of an interaction which we now recognize as the hydrogen bond.

Investigations on fluorescence led him, as indeed, independently, Trautz in Germany and McLewis in Great Britain, to develop a radiation theory of chemical reaction. While this theory in its general terms was shown by Lord Cherwell to be untenable, yet it led to a clearer understanding of the part played by the internal energy and restraints imparted by the quantum theory on the rate processes in both chemical and physical changes. It is also noteworthy that Perrin's investigations on fluorescence led him to examine soap films containing fluorescent material and to make the first measurements on stratified soap layers.

Apart from these subjects to which Perrin devoted much of his time, the volume is enriched by a number of minor contributions in the form of speeches delivered to commemorate distinguished men of science and on scientific subjects of general interest. In all these, Perrin's remarkable clarity of thought is evident, and this volume will serve as a useful corrective to those who think that science has become too complicated to be generally understood.

Eric K. Rideal

A GUIDE TO ANTHROPOLOGICAL FIELD-WORK

Notes and Queries on Anthropology

Sixth edition revised and rewritten by a Committee of the Royal Anthropological Institute of Great Britain and Ireland. Pp. xii+403. (London: Routledge and Kegan Paul, Ltd., 1951.) 28*s*. net.

THE sixth edition of "Notes and Queries on Anthropology" appears in a new format and with a completely revised contents. The Royal Anthropological Institute, which has taken over the responsibility for this edition from the Anthropological Section of the British Association, is to be congratulated on its work. The new edition, like the fifth, is divided into four sections which cover the fields of physical anthropology, social anthropology, material culture and field antiquities, respectively. Appendixes give useful advice on photography, cinematography, collecting and packing of specimens, preservation of bones, and the making of paper squeezes.

The sections on physical anthropology and field antiquities are short and presume some previous acquaintance with techniques of investigation in these fields. Both are an advance on the last edition, and the section on physical anthropology now includes a guide to the investigation of blood groups. The bulk of the book is given over to the sections on

social anthropology and material culture. The latter is the least changed of any in the book, a reflexion of the sound work done by the pioneers in this field. The section on social anthropology has become almost a text-book for the subject, which should be useful to the student as well as to the field anthropologist and to the amateur who is in need of guidance in the recording of material available to him. The definitions have been written into the text, and an attempt has been made to place the collection of data in relation to the problems which still require investigation. This is a great improvement on the old form of "Notes and Queries", which presented the investigator with a long list of imperative questions and left him to sort out for himself, if he could, why he should ask any or all. Some of the old formlessness still remains; but the field-worker can now feel that he has at last a guide to direct his work into meaningful fields rather than a formless checklist. It should lead to an improvement in field-work and in the publication of results.

A comparison of the new volume with the fifth edition, which appeared in 1929, illustrates the great advance that anthropological investigations have made in the intervening years, both in methods of field-work and in an understanding of the data collected. There is a demand for new types of information, and also for the collection of quantitative data and the use of proper sampling methods. These are welcome signs of the maturity which the subject has now reached. There is also evidence that the British social anthropologists are defining their field of study much more rigidly than in the past. No hint is given of the recent developments made by American anthropologists in the collection of data for the study of the influence of culture upon personality. There is no reference to the use of various projective tests, the collection of life-histories, or even the collection of dreams, although those responsible for the fifth edition considered this last a worthy field for investigation. This is an omission in a general guide to the field of anthropological investigation. The social anthropologists would probably justify the omission on the grounds that these studies belong to the field of psychology. This may be true, but field-workers are advised to pursue other investigations which seem equally to belong to the field of psychology, for example, "Observations of child behaviour in simple societies are of great value as checks on current psychological theories of child development. Thus theories concerning innate aggression, and aggression as a reaction to frustration, need to be checked by means of direct observation of infants and children in diverse cultures" (p. 101).

This is the only major omission. "Notes and Queries" in its new form should have a long and useful life.

SCIENCE FOR NON-SCIENTISTS

Science and Common Sense

By James B. Conant. Pp. xii+371. (London: Oxford University Press, 1951.) 21*s.* net.

THE President of Harvard has obviously enjoyed himself in writing this book. He describes it as a work on the methods of science for the general reader, and so indeed it is; but he also says that nearly all the ideas and much of the technical material have been presented more than once in lectures to audiences of undergraduates. Moreover, the problem of teaching natural science as part of a general education has been actively and frequently discussed with his academic colleagues for a period of years.

Books on science for the layman are all too frequently written either by amateurs with no real qualifications for that difficult task, or by professional men of science who are not really able to think themselves into the frame of mind of the common man. Prof. J. B. Conant's book is something different, something which cannot be criticized on either ground—a book written by a man of science who obviously possesses not only exceptional qualifications and experience, but, as the reader soon discovers, a flair for imparting his knowledge divested of its technicalities. The non-scientific reader can almost believe that the author is 'one of us'. Appearances are deceptive. The old scientific hand will have no difficulty in detecting profound knowledge behind the simple explanations.

Science has become such an important element in our lives that it is no longer possible for the intelligent citizen either to ignore it or to leave it to the experts. Many non-scientific people in all walks of life are brought into daily contact with the results of scientific research and are called upon to determine policy and to make decisions on matters which are fundamentally scientific. It is Prof. Conant's thesis that, while it is obviously impracticable to give such people the full knowledge of science which scientific workers themselves possess, it is by no means impossible to teach them something of the 'tactics and strategy' of science; that is to say, to give them an understanding of what goes on in scientific laboratories and of the methods by which scientific problems are attacked and solved.

The device he particularly advocates is the use of a series of 'case histories'; and a considerable part of the book is devoted to Robert Boyle's work on pneumatics, Galvani's and Volta's discoveries in electricity, Pasteur's studies in fermentation, and many other great achievements in the progress of natural knowledge, used as illustrations of the manner in which science proceeds. The explanations of these steps in scientific history are illuminating; they have that completeness and freedom from ambiguity which comes only from a mastery of the subject.

Throughout the book the author's opinions are stimulating and provocative. There is, for example, his definition of science as "an interconnected series of concepts and conceptual schemes that have developed as a result of experimentation and are fruitful of further experimentation and observations". He will have none of science as the mere acquisition of knowledge. A piece of work is not true science if it does not lead to fresh ideas and further experiments. Then he crosses swords with all those who hold the belief that there is something which can be called a 'scientific method', with its implication that scientific workers are the only impartial inquirers. Not least interesting are his comments in the later chapters on some of the modern problems—the consequences of the replacement of independent investigators by research teams, the implications of the secrecy restrictions imposed by governments, science in the communist State, are examples of these.

The general reader, for whom it is intended, will learn much from this book; but his scientific friends will be well advised to borrow it from him.

THOMAS MARTIN

A History of Science, Technology and Philosophy in the 16th and 17th Centuries

By Prof. A. Wolf, with the co-operation of Prof. F. Dannemann and A. Armitage. (History of Science Library.) New edition, prepared by Dr. Douglas McKie. Pp. xxvii+692+68 plates. (London: George Allen and Unwin, Ltd., 1950.) 42*s*. net.

WHEN Prof. A. Wolf's book appeared in 1935, it was warmly welcomed and praised as an important addition to scientific literature. Since then it has become an indispensable text-book and source of information on the progress of science in the sixteenth and seventeenth centuries, valuable alike to men of science themselves and to others more generally interested in the growth and development of natural philosophy.

It may be suspected that those who are actively engaged in research and experiment do not always realize how much they owe to the scientific history they have themselves absorbed in the course of their work, and tend to underrate the value of historical studies. In recent years this tendency has been corrected; the history of science and technology has been cultivated as an almost virgin field, and there has been a growing appreciation of the importance of the historical approach to science, particularly to those who wish to obtain a better understanding of its possibilities and its limitations. One indication of this change is, for example, the formation, a few years ago, of the British Society for the History of Science; and that there has been such a change is in no small measure due to the publication of works of scholarship such as this.

It needs no telling that Prof. Wolf's book deserves the praises which have been bestowed on it, and this new edition is very acceptable. It has been prepared by Dr. Douglas McKie, who has corrected a number of errors in the text and extended the bibliographies at the ends of the chapters.

Arithmetical Questions on Algebraic Varieties

By Prof. Beniamino Segre. Pp. vii+55. (London: Athlone Press, University of London, 1951.) 10*s*. 6*d*. net.

PROF. B. SEGRE, of the University of Rome, is the chief pioneer in the application of the concepts and methods of classical algebraic geometry to problems in the theory of numbers. His publications on this subject, started in 1934 and still continuing, have been an inspiration to many other research workers. In 1950 the Senate of the University of London invited him to give three lectures at King's College, and these lectures, supplemented by an ample bibliography, have now been published by the newly established Athlone Press of the University.

The first lecture deals with the geometry of quadratic forms in an arbitrary field, and starts by recalling some results given in the author's "Lezioni di geometria moderna" (Bologna, 1948). These are considerably developed, at least in outline, with references for a complete treatment of the theorems given without proof. The second lecture deals with algebraic geometry and Diophantine analysis, and shows how projective and birational geometry may be used in various branches of the theory of numbers. The third lecture, entitled "Problems concerning rationality and the theory of the base", may be considered as an extension of the subjects dealt with in the second lecture.

It is stated that the purpose of the book is to offer an exposition which will be of value not only to research workers but also to a more general range of mathematicians. There is no doubt of the value to research workers, but a few more pages of introductory explanation would have made the book more intelligible to those mathematicians who are unfortunate enough to lack a previous acquaintance with the subject.

H. T. H. PIAGGIO

Finite Matrices

By Dr. W. L. Ferrar. Pp. vii+182. (Oxford: Clarendon Press; London: Oxford University Press, 1951.) 17*s*. 6*d*. net.

WITH the exception of Chapter 5 and most of Chapter 8, this book covers well-worn ground, but is well and clearly written. In Chapter 5, Dr. W. L. Ferrar considers infinite series of finite matrices and functions of finite matrices. The initial ideas can be extended to infinite matrices[1]; but, of course, more restrictions are then required. Some interesting new results are given by Dr. Ferrar in this chapter.

In Chapter 8, notes are given on the resolvent of a finite matrix, on positive-definite quadratic forms subject to linear conditions, and on sets of anti-commutative matrices. The remaining chapters give an easily readable account of introductory matter, equivalent matrices, equivalent λ-matrices, collineation, congruence and matrix equations. The book is in every way suitable for the class of readers which the author has in mind, as expressed in the preface—namely, graduate students and undergraduates whose degree courses involve more matrix theory than a text-book of elementary properties will provide.

There is a great need for text-books of this standard in several other branches of mathematics.

R. C. COOKE

[1] See Cooke, R. G., "Infinite Matrices and Sequence Spaces", 27, 30, 14, 38 (Ex. 18, (ii)), etc. (Macmillan, 1950).

Man on his Nature

By Sir Charles Sherrington. (The Gifford Lectures, Edinburgh, 1937–8.) Second edition. Pp. viii+300+8 plates. (Cambridge: At the University Press, 1951.) 30*s*. net.

SIR CHARLES SHERRINGTON'S Gifford Lectures at the University of Edinburgh, in which he put forward the philosophy of a physiologist, are now too well known to require any summary. They have been twice reprinted, and in this new edition have been substantially revised. It is gratifying that the author has been able to do this work, and his method of doing it is much to be recommended. Many writers revise by adding on extras, lengthening the book and loosening the argument. Sir Charles's method is the reverse; he has cut down the length by about a quarter and tautened up the argument.

In recent years there have been a number of pronouncements by men of some scientific repute about the nature of man and of the universe in general. These have been made very much *ex cathedra*, in an irresponsible, even hysterical, fashion; but have been accepted with enthusiasm by the more impressionable of the public, to the dismay of others who care for the good name of science. We have in this book an invaluable counterpoise. In technical scientific matters Sir Charles has never confused loose speculation with established knowledge. Speaking on philosophical matters, he is one who weighs his words, and is eminently sane, cautious and responsible. He does not claim to possess the key to unlock all doors, and for that very reason speaks with great authority.

A. D. RITCHIE

SOME TAXONOMIC AIMS, METHODS, AND PRINCIPLES*

THEIR POSSIBLE APPLICATIONS TO THE ALGAE

By Dr. W. B. TURRILL
Royal Botanic Gardens, Kew

CLASSIFICATION is a sorting of units into classes. The units may, of course, be anything, from abstract ideas to botanists themselves. We are here concerned with plants, and it is necessary only to remind ourselves that in general botanical classification our units are (*a*) whole plants throughout their life-histories and (*b*) living plants. These bases of general classification in no way minimize the importance of special classifications, such as those based, say, on ecology, cytogenetics, or phylogeny, or the use of preserved, dead samples in herbaria, in pickle bottles, or on microscope slides.

Secondly, we are all familiar with the hierarchical scheme of orthodox taxonomy with varieties, species, genera, families, etc. A few years ago Prof. Lam, of Leyden, proposed the useful term *taxon* (plural, *taxa*) to designate any taxonomic unit. The orthodox scheme has been applied to all groups of organisms, even to bacteria and to lichens with their dual organization, and, recently, even to the problematical viruses. Some of us have raised the question whether other schemes would work better; but none of wide general applicability has yet been proposed and practically tested. Undoubtedly, the orthodox scheme does break down in certain groups, for example, in the apomictic *Hieracia* or *Taraxaca* and in hybrid swarms such as occur in *Centaurea* in Great Britain. Whether it can be patched up or modified or whether it would be more convenient entirely to replace it is, in my opinion, a question that cannot yet be answered on sound grounds. More facts are needed, especially cytogenetical and ecological (in the broad sense). Meantime there is much of interest and importance in the principles of modern taxonomy and in the application of these to the various groups of plants.

There is no need to explain in detail the importance of taxonomy. It is basic to every other kind of study of animals and plants. No one knows how many species of Algæ will yet be recognized in the world's flora. Smith (1938) gives figures of accepted species for the various groups, and adding all these figures together the total of 17,535 is obtained. This, I should assume, is a very conservative estimate. It is, however, a sufficiently large number to show the need for a classification of species for practical convenience. The number of individuals, if known, would have to be expressed in figures approximating to those with which astronomers delight to daze us. Hence the need for some unit expressed as or equivalent to what is generally termed a species and the grouping of species into genera and these into families. Apart, however, from the use of classification as a means of "finding one's way about in" or in recording or passing on information concerning Algæ, or any other group, there are many fascinating theoretical problems concerned with methods, principles, and results. No satisfactory and comprehensive account of these has yet been published; but increasing attention is being given to them and, with the hope that contributions will be received increasingly from algologists, some of the theoretical aspects of taxonomy will be considered.

* Substance of a paper read at a meeting of phycologists at the British Museum (Natural History) on January 3.

Characters

Classification is a grouping together of items having one or more characters in common—the class-characters. For taxonomy, 'a character' is any descriptive statement regarding structure or behaviour which the taxonomist abstracts from the whole organism. Such descriptive statements can often be expressed in quantitative terms, and to them the rules and methods of statistics are more or less readily applicable. There are, however, many 'characters' that cannot be expressed, or cannot be most conveniently expressed, at present, in strictly statistical fashion. For example, in Algæ you use characters of colour, as 'red', 'brown', 'yellow-green', 'grass-green', and so on. These can be matched with colour charts and the terms could, in theory, be given a degree of precision that might make it worth while to deal with colour characters statistically. On the other hand, one can hazard a guess that one day biochemical analysis will be so advanced that a colour character can be replaced by a statement that the organism showing it has such and such percentages of chlorophyll *a* and *b*, xanthophyll, carotin, phycocyanin, phycoerythrin, phycochrysin, fucoxanthin, and other chemicals identified by empirical and structural formulæ. Then, I suppose, one may say a qualitative character has been descriptively replaced by a mass of quantitative details.

It is important to note that a taxonomic character must be defined as precisely as is essential for its use for a given purpose. We are badly in need of an up-to-date glossary of botanical terms, and we have already suggested from Kew that the International Association for Plant Taxonomy should consider if this can be undertaken. A taxonomic character is used for description of a structure or a behaviour and is not necessarily the lowest unit of description. For example, take a shape. We read (Newton, "Handbook of the British Seaweeds", 278) that *Dilsea edulis* has an "obovate" frond. This means that the frond is flat, is longer than broad, and has the broadest part above the middle of the length. The character 'obovate' can be analysed into three separate 'characters', if desired: length, breadth, and position of the greatest breadth. It could also be analysed into an indefinite number of 'characters' by measuring the breadth at an indefinite number of intervals along the length, or the length at an indefinite number of intervals across its greatest breadth. Nevertheless, 'obovate' is a useful term to designate with some degree of accuracy a given character—that of outline shape. The 'compoundness', if one may use the word, of many 'characters' which we, with pragmatic justification, record by unit descriptive terms is often evident in genetic studies. A leaf shape, say ovate, may be mainly determined genetically not by one gene

but by several genes. For example, in *Silene cucubalus*, leaf shape is controlled by genes influencing length and others influencing breadth, yet we may be sufficiently precise for many purposes in describing a leaf of a bladder campion as ovate, obovate, elliptic, lanceolate, or linear. A taxonomic 'character' is not to be equated with the determination of a single gene difference or of any genom. Taxonomic characters stand by their own justification for precise description. One can, of course, prepare a classification of characters. For example, there is much to be learnt from the classifications of characters given by Lindley, Bischoff and Asa Gray.

Special and General Classifications

For any group of organisms it is possible to make many different classifications by using a limited number of characters chosen for some special purpose. It is somewhat misleading specially to call such classifications 'artificial' because all classifications are in some degree 'artificial'. Anyhow, they are often most useful and the more of them there are the better for the taxonomist, since they direct attention to 'characters' he might otherwise miss. Thus, habitat classifications of Algæ into terrestrial, aquatic, fresh-, brackish- or salt-water, sun and shade, corticolous, epiphyllous, etc., come into this category of special classifications, as would also those based on number, structure, and behaviour of chromosomes. Another special classification would be according to size; another on the basis of geographical range; another according to life-form; and another on use to mankind. Any classification based on a restricted number of morphological or physiological characters is a special one, and it is the more special the fewer the number of characters and kinds of characters used.

A general classification is one in which all known characters are taken into consideration. Ideally, one should say all, or at least all ascertainable, characters are to be used in preparing a general classification. There is every grade between an extremely special and the most general classification. Given the facts, it is much easier to produce a sound special than a logically perfect general classification. Not only does a general classification involve the use of all possible data but also it serves as wide a range of purposes as possible. Perhaps it would be fairer to say that the wider the range of purposes well served by a classification the 'better' it is. However, neither the taxonomist nor his colleagues in other branches of biology or, indeed, non-biologists, can wait for the perfect taxonomy. We have to accept for immediate use the most satisfactory classification we can prepare or find already prepared and improve it in the course of use. Taxonomy is no more static than any other branch of biology, though like the latter it has its up and down periods. The idea of alpha to omega taxonomy is sometimes instructive. First, or alpha, classifications are full of sins of omission and commission. They are gradually improved towards the ideal omega classification, which will never be reached, which cannot be reached, so long as evolution continues. For plants, an alpha classification nearly always has a basis of gross morphological characters only. Later, data from anatomy, cytology, genetics, phytogeography, ecology, biochemistry, etc., are added. For the seed-bearing plants some of us like to think that we are here and there progressing along the Greek alphabet, and have reached beta or gamma. At least, we have learnt that much more remains to be done than has yet been done and that data from all branches of biology, and often from outside biology, can be used in plant classification and must be used if we are to make the best progress.

Individuals

In plant taxonomy we usually think first of classifying individual plants into species. It is, however, worth recalling that there are difficulties in defining and sometimes in practically determining 'individuals' in many groups of plants. To define an individual as the total produce of a zygote does not work in practice because of multiplication by asexual spores and a range of effective mechanisms for vegetative propagation. Again, to consider as an individual every physiologically independent plant also leads to difficulties since there is every degree of physiological independence. In colonial Algæ, in lichen symbionts, in apomicts, and in phanerogamic chimæras there are special problems of individuality. The ecologist has to resort to various devices in both descriptive and experimental studies when he wishes to record numbers of units in a piece of vegetation. In the seed-bearing plants we have the useful terms 'clone' and 'ramet': the former to designate the total mass separated into physiologically independent units by vegetative multiplication from the product of one zygote and the latter to designate any one of these units. Genetically, apomicts are clones, though from other points of view, ecological for example, they are best considered as consisting of individuals rather than of ramets. Additional problems arise both with clones and with apomicts when somatic mutation or somatic segregation occurs.

Species

It has long been, and is, widely held that the species is the most important category of plant classification. In some ways this is true. If one asks: "What is the name of this plant?" one expects a specific name as an answer. Floras and manuals deal mainly with species. The ecologist, geneticist, or the applied botanist, refers to his material most often as species, though it is true that gardeners often require varietal names. There are, however, dangers in allowing species pride of place to all other taxa. Species are, in my opinion, just as much matters of scientific convenience as are genera, families, or any other taxonomic category. There is nothing sacrosanct about a species. A species is a population of individuals (including clones or ramets) and as such is always changing its composition and the sum of its characters. The question, Does Nature or the taxonomist make a species?, is a good, and nowadays fairly harmless, subject for debate. The simplest answer is that Nature makes individuals agreeing in certain characters and disagreeing in others, and the taxonomist decides if the character resemblances and differences are of what he calls specific rank or value.

It is a matter of experience that, say, a botanist well acquainted with the British phanerogamic flora can go into a field or wood or to a sand-dune or salt marsh and determine, without hesitation, 99 per cent or more of all the plants he can see into species. Moreover, other botanists will agree with him. I assume the same would hold in the midst of algal communities. This is the pragmatic justification of the species concept. Nevertheless, intensive studies show that the concept of species is not absolute. More frequently than is realized by many students it breaks down. We cannot, at least in the flowering

plants, apply the criterion of fertile inbreeding to species to the extent it is applied, in theory, for animals by many zoologists. It would take too long fully to analyse this subject here, and it can only be said that in the flowering plants hybridization between taxa appears to be of much more frequent occurrence than it is among animals. More-or-less frequent results are a blurring of boundaries between species, the exchange of genes and the consequent greater or less mix-up of characters, the formation of hybrid swarms, and even the amalgamation of species. This is additional to the changing of species by mutation. My own experience of these problems has been intensive in the species of only a few genera of flowering plants, especially in *Silene*, *Centaurea*, and *Saxifraga*; but extensively, and, of course, much more superficially, I have met with intricate problems of classification in groups of species of many genera, of both temperate and tropical floras, belonging to diverse families. I may instance *Thymus* and *Dianthus* in the Balkan Peninsula, *Fritillaria* in the Himalaya, and *Clematis*, *Clematopsis*, *Olea* and *Jasminum* in tropical Africa. It would interest me greatly to have information on hybridization, hybrid swarms, gene exchange, and anything else connected with the breakdown of specific limits in the Algæ.

The increasing uncertainty or diversity in the application of specific limits in a considerable number of groups of flowering plants is reflected in the use of the term 'aggregate species' with 'microspecies' grouped under them. A slight modification is to accept 'aggregate species' with 'subspecies' or simply unnamed 'groups' more or less clearly distinguishable within them. At the other extremes are the 'splitters' who would give a specific name to every variant. Aggregate species are sometimes called 'Linneons' and microspecies 'Jordanons'.

Danser, in 1929, introduced three new terms which sometimes coincide and sometimes do not coincide with taxa. A 'comparium' is the whole of the individuals that can be combined, directly or indirectly by crossing, whether the hybrids are fertile or infertile. A 'commiscuum', within a comparium, is the whole of the individuals that can cross together to produce fertile hybrids. A 'convivium' is, within a commiscuum, a group of individuals that can be more or less sharply distinguished from other groups by characters other than inter-fertility, and that is maintained as a group by some form of isolation other than inter-sterility. Turesson has another, probably better known, scheme. Unfortunately, the terms he used were not clearly and logically defined when they were first used—nor the definitions afterwards adhered to by Turesson himself and other authors using his terms. Turesson started from an ecological point of view, and by using experimental methods showed clearly how complex in composition are many taxa accepted as Linnean species. Finally, he had three terms: 'cœnospecies', or the whole complex of individuals having a common origin and divisible into 'ecospecies', the individuals of which can cross together to give fertile offspring and cannot so cross with individuals of other ecospecies. Within an ecospecies there can, frequently, be distinguished 'ecotypes' that are separated from one another by different genotypical responses to a particular habitat. It seems a pity that the term 'ecospecies' was attached to a genetic and not an ecological definition. For this reason Danser's terms are to be preferred; but, actually, they are being less used than are Turesson's in Great Britain and the United States. The taxonomist recognizes the value and the interest of these schemes and acknowledges that with further progress towards an omega classification their importance will increase. His criticisms are: (1) by themselves the terms and their definitions result in special, not general, classifications, or, at any rate, not fully general classifications; (2) the criteria are difficult to apply so far as sterility or fertility is concerned; (3) there is every degree of sterility or fertility; (4) the differential criteria, in theory at any rate, refer to what can be and not necessarily what is in the wild.

Ecads

Turesson's methods, like those of the British Ecological Society's Transplant Experiments at Potterne and of Hall and Clements and later of Clausen, Keck and Hiesey in the United States, have shown the value to taxonomists of field studies combined with simple cultural and genetical experiments. It is generally held that differential characters of taxonomic value must have a genetic basis. Habitat 'modifications' or 'fluctuations' are not to be used for distinguishing taxa, at least above the level of 'forms' or ecads. Careful field observations often enable ecads to be distinguished from ecotypes with a high degree of probability, but there are many phenotypes that must be tested experimentally before one is certain they are or are not distinct genotypes. The requisite tests include growing a reasonable number of individuals from seed and from ramets under as wide a range of environmental conditions as possible and using them in suitably planned genetical experiments. All data must be recorded since 'negative' results may be as important taxonomically as 'positive' ones. Moreover, the degree or range of plasticity is itself a taxonomic 'character'.

Genetics and Taxonomy

Genetics is influencing taxonomy in two ways: by providing new facts and explanations and by emphasizing the value of experimenting with large numbers of individuals. From our present point of view, the latter may be the more important. The facts provided by genetical research in any one taxon include recognition of genotypic characters, the results of their segregation and aggregation, character linkage, occurrence of mutations, the limits and degree of fertility or sterility, and the existence and effects of hybridization. All these are of taxonomic importance. It is, however, true that genetical experiments are limited to about the level of the species, with relatively few exceptions. Most crossing is between individuals within one species. Interspecific crosses are not uncommon though rarer in the wild than in gardens. Intergeneric crosses are rare, except perhaps in the orchids. Crosses between families have not been recorded, so far as I know, even in the United States or in the U.S.S.R. Nevertheless, comparison of genetical behaviour within one species with that within another, of the same or a different genus or family, may reveal taxonomically interesting resemblances or differences. For example, the *FFMM* scheme for 'sex' holds for *Rubus indœus* and for *Ranunculus acris*. Apparently it does not hold for the Labiatæ or for the Caryophyllaceæ, at least without considerable modifications.

We shall return to genetical explanations of uniformity, similarity and variation later. It is, however, worth passing a few comments on genetical

methods. The taxonomist has, usually, no time to undertake genetical experiments on any large scale. Yet I am strongly of the opinion that every taxonomist should know, if possible by personal experience, something of what can be learnt in genetical practice. In this, one has to use living plants in large numbers. They are studied at all stages of the life-history, from germination to seed setting, and characters are often scored as changing phases of growth rather than as fixed resemblances or differences. Statistical methods can be employed on abundant material of known relationship and immediate origin. Many of these lessons of methodology can also be learnt by the discipline of autecological experiments, such as those used in the study of ecotypes, and better still by combining genetical and ecological research on the same material. I happen to know a little about the genetics and ecology of some species of the *Behen* subgenus or section of *Silene*. Lately, I have had to work on the taxonomy of Ranunculaceæ and Oleaceæ of tropical East Africa by herbarium methods only. The experience gained by intensive studies on a few species of *Silene* has been most valuable in attempting to rationalize classification of the many more species in the buttercup and olive families in East Africa; but how often have I realized that only planned field work and genetical experiments can show how far my tentative classification will have to be revised to make it the best and most general that is possible.

Karyology

There is no need to discuss with algologists the taxonomic importance of either histology or many aspects of cytology. You have to use the compound microscope sometimes to see your plants at all as individuals, certainly to see their structural characters. In the Spermatophyta, histological characters are now generally recognized as often having taxonomic value. Cytological ones outside the nucleus have been little used. In Algæ, you are fully familiar with the taxonomic worth of cell-wall structure, chloroplast size, shape, and number, flagella, eye-spots, vesicles, food reserves, etc. Chromosomes, however, raise many problems for the taxonomist, some perhaps very similar in Algæ and in seed-bearing plants, others apparently different. It is not for me to discuss your special difficulties of alternation of generations, of gametophyte or sporophyte, of haplonts, diplonts, haplobionts, or diplobionts. On the other hand, if present orthodox cytogenetic theory be correct, the chromosomes in some way 'carry' the genes controlling, within environmental limits, the development of 'characters', whether in *Fucus* or in *Ranunculus*. Their number, structure and behaviour may, therefore, be expected both to be correlated with taxonomic status and to help the taxonomist in determining this. I would like to relieve myself of one grouse: the taxonomist is too often uncertain what material the karyologist has used. Frequently plants examined for chromosomes have not been adequately determined and voucher specimens have not been preserved. One other criticism must also be made. There is sometimes a tendency to over-value chromosome characters in relation to taxonomy. A classification based on chromosomes only is a special, not a general, classification. Like all special classifications, it may have very important special uses but it cannot replace a general classification. In other words, at the present time at any rate, chromosome characters must be considered together with all other morphological and physiological characters and given a balanced value as differentials.

Polyploidy has come much to the fore of recent years both in cytogenetics and in taxonomy. The discovery that within what has for long been accepted as one species there are different chromosome numbers, in typical polyploidy multiples of a basic number or in polysomy the addition or subtraction of single chromosomes, raises practical taxonomic problems some of which still await solution. Should one consider the polyploids as different species or as subspecies or varieties of one species? Should some special terminology and nomenclature be devised for them? My own view is that, at present, every taxon must be examined on its own merits with the data available for it. Our ignorance is still so great that generalizations are likely to be false or, for procedure, soon to become impracticable. One has only to think of the huge number of tropical species that have never been examined for their chromosomes. Even for temperate plants, very few wild species have been cytologically examined for more than a few individuals of known origin. Moreover, cytologists sometimes contradict one another, and what is the taxonomist to do then? We conclude that karyological data will have to be included increasingly as taxonomic 'characters', but they must not unduly dominate or be allowed to outweigh other characters of structure and behaviour.

Variation

Variation is not merely the spice of life, it is the very essence of living. Within a species, or any other taxon, variations occur or disappear from time to time. There is no *a priori* reason why even a pure line should remain 'pure' for an unlimited number of generations. Actually, in the seed plants, the purity of pure lines is largely hypothetical except for the rare occurrence of apomictic doubling of chromosomes in a haploid. One would like some detailed studies of variation in those Algæ designated haplonts, that is, where only the zygote is diploid. How, and at what stage in the life-history, variations occur in such plants might throw much light on the more complicated situation in diplonts or 'almost diplonts' like the seed-bearing plants. In the latter, modern genetic explanations of characters and character combinations allow two sources of variation of taxonomic importance: mutation and hybridization. The former includes changes in the number and linear structure of the chromosomes, including polyploidy, polysomy, inversions and the like, and also changes at single gene loci. It is usually stated that gene mutations are more important than chromosome mutations in long-range evolution. It is probably true that both chromosome mutations and hybridization have been more important in the seed plants than in animals. One would like to know what is the position of the Algæ in this respect.

Whatever may be the causes and the mechanisms of variation, the taxonomist has to deal with the results. To a certain extent, modern genetical explanations are useful in attempting, by classification, to bring order into apparent chaos. Gene mutations are often said to be random. Certainly they can result in change in the characters of any structure or behaviour. In *Silene*, for example, we have genetic variation of characters for stems, leaves, inflorescences, calyx, petals, stamens, gynœcium, fruits, seeds, and seedlings, as well as for hardiness and disease resistance. On the other hand, there are

taxa in which mutation seems especially to play upon one organ, as the utricle in *Carex* or the legume in the Leguminosæ, or upon a few organs, as the column and labellum in the orchids or the corona and the pollinia in the Asclepiadaceæ. One may postulate a group of unusually labile genes behind such variation which not infrequently suggests orthogenesis, even if this concept be now heterodox.

Mutations occur and, though the majority of individuals having them are born only to die without survivors, some persist in offspring. If they have positive or neutral survival value they may, with some luck, become diffused through a taxon to the limits of crossability. In this way a taxon, such as a species, changes in the sum of its characters. Sometimes mutations adapt the individuals in which they occur only to conditions found in a portion of the range of the taxon. Hence arise geographic species or subspecies, or sometimes clines. Often mutations diffuse more or less gradually through populations, sometimes by interspecific hybridization from one species to another.

Reticulation

This brings us to a consideration of a phenomenon that is widespread in all plant groups and to which insufficient attention has been given. It is often a practical bugbear to the taxonomist and yet is a fascinating subject for speculation. As a taxonomist, I prefer to use Robert Brown's term "reticulation" in referring to the appearance in different taxa of the same or similar characters in different combinations. If characters always appeared in the same combination, if there were complete correlation in their appearance, taxonomy would become purely mechanical. Actually we find 'parallelism', 'homoplasy', 'homologous variation', or whatever one likes to call the phenomena the result of which to the taxonomist is a network of characters many of which are repeated again and again in various combinations. Fritsch and others have listed striking examples for the Algæ, involving sometimes structures, sometimes functions. The 'causes' of reticulation are probably not always the same. The 'parallel mutations' we have recorded for *Silene cucubalus* and *Silene maritima* are no doubt connected with the close genetic relationship of the two species. It is essentially the 'same' gene that mutates in either species. It is more difficult to explain in this way the parallelism in style variations in the western American and eastern Mediterranean species of *Fritillaria*. Finally, what can one make of the parallelism, in structure, development, range of variation, and functioning, between the pollinia of the Asclepiadaceæ and Orchidaceæ?

Perhaps in its final results mutation is not so random after all. Perhaps some mutation is less random, some more. It is orthodox to say that the randomness of mutation is controlled by natural selection. No doubt to some degree it is. Nevertheless, the taxonomist, meeting so many characters in so many combinations and yet again and again finding characters repeated in families it is not reasonable to suppose closely related phylogenetically, feels he does not yet know all about the methods of evolution.

Phylogeny

I have left to the last some remarks on phylogeny, which may be defined as the origin and development of a phylum—the word phylum here signifying any taxonomic group. In line with modern terminology it would be better to talk of taxogeny, but the word phylogeny is now so widely used that it would be difficult to replace it. Biologists frequently state that a taxonomic system must be based on phylogeny if it is to be the best possible. For the angiosperms, and I suppose the same is true for the Algæ, classification is based on resemblances and differences mainly of structure. The relevant fossil records are so imperfect and genetical knowledge is so restricted to about the species level that we have not the data on which to construct a phylogenetic classification. This is not to say that phylogeny is not a scientifically sound subject for study, nor is it in any way to decry phylogenetic speculation. Moreover, it may well be that common origin is the true explanation of much of the community of characters revealed by taxonomic research and used in the determination of taxa. Further, phylogenetic possibilities or probabilities, even when unsupported by direct evidence, may suggest improvements in a proposed classification and especially new lines of research. Nevertheless, to describe a taxonomic scheme as phylogenetic is misleading unless the phylogeny of the groups involved is known from direct observation or experiment (and this can rarely be) or, at least, from good series of relatively dated fossils. So-called phylogenetic 'trees', if well constructed, show graphically to some extent the degree of resemblances and differences between the groups considered. Why not be honest and describe them as such?

Conclusions

The foregoing is a brief outline of some of the possibilities of improving the taxonomy of plants by understanding more clearly the principles of classification and by utilizing data on a much wider scale than is at present usual. The many new facts being revealed by modern researches in ecology, genetics, cytology, biochemistry, and so on, have to be taken into consideration in the new systematics. There are two aims in plant taxonomy. One is to make the best possible classification for the most precise and easiest determination of individual plants. This is the practical and in many ways the altruistic aim of taxonomy. The taxonomist has, however, a second aim, or group of aims, in that he expects his researches to reveal much concerning the problems of range, distribution, and evolution of floras and of taxa. It is, indeed, difficult to see how such problems can even be imagined, much less clearly stated, until taxonomic studies have so grouped the plants and the facts concerning them that they can be dealt with as a limited number of classes and not as an unlimited, unconnected number of individuals. There is, however, more than this in taxonomic research. Time and again it provides or suggests the solution, or a part of the solution, to problems, other than purely taxonomic, raised by itself or raised by workers in other branches of biology. Final proofs may have to await cytogenetical or ecological evidence derived from experiments, but the experienced taxonomist can often suggest the lines these should take. One example must here suffice. Preliminary taxonomic investigation showed great variability in the British knapweeds (*Centaurea*). Many so-called 'species' were described. Further collecting and comparison of series of herbarium specimens suggested that hybridization occurred in the wild on a considerable scale in the southern part of England and that most of the so-called species were hybrids, back-crosses, or

segregates from hybrids. Analysis and synthesis involving more than six hundred controlled crosses and selfings correlated with detailed statistical analysis of wild populations have proved the 'herbarium' explanation to be correct.

By linking up taxonomy still more closely with ecology, cytogenetics and other modern developments in biology, it will be improved, its basis and outlook broadened, and more young research workers will be attracted to it. All this is, indeed, happening. The advantages are reciprocal. The cytologist, geneticist and ecologist, both give help to and receive help from the taxonomist. Problems so often need team-work for their solution that it is essential for specialists to know something about the materials, aims and methods of one another's researches. Our divisions are at best artificial conveniences, and taxonomists neither claim absolute national sovereignty over any group or field of research nor recognize such a claim by other biologists.

FRICTION AND LUBRICATION

ROYAL SOCIETY DISCUSSION

A FULL-DAY discussion on friction and lubrication was held in the apartments of the Royal Society at Burlington House on April 19, 1951. The meeting was opened by the president of the Royal Society, Prof. E. D. Adrian, and the leader of the discussion was Dr. F. P. Bowden (Cambridge). Some two hundred people attended, and those presenting papers and participating in the discussion included workers from Australia, France, Holland, Sweden and the United States. The programme fell into three main parts: friction of metals, friction of non-metals, and boundary and extreme-pressure lubrication.

Metallic Friction. In the opening paper, Dr. Bowden discussed the basic mechanism of friction, and illustrated some of his main points with some simple but striking experiments. He showed that, in general, when surfaces slide on one another, intimate contact occurs between the surfaces over a very small area and in these regions strong junctions are formed —the frictional force being primarily the force required to shear these junctions. The real area of contact, and hence the friction, is proportional to the load and independent of the size of the surfaces. Under suitable conditions these junctions provide strong normal adhesion between the surfaces, and with soft metals such as indium the adhesion is of the same order of magnitude as the frictional force. Lubricant films reduce the amount of intimate metallic contact and so reduce both the adhesion and friction. Conversely, the removal in a high vacuum of all traces of surface oxide and other contaminant films leads to gross seizure between metals even at room temperature. Most of the frictional energy appears as heat, and because it is localized at the small regions of contact very high local temperatures may be generated at relatively low loads and speeds. This is particularly marked if the surfaces are poor thermal conductors. Finally, the frictional properties of some low-frictional materials were discussed, and it was shown that porous materials impregnated with polytetrafluoroethylene, or molybdenum metal attacked chemically to form molybdenum sulphide *in situ* on the surface, have very low coefficients of friction up to very high temperatures. It was suggested that a stage is now being reached where it should be possible to construct surfaces having desirable frictional properties for specific practical application.

The five papers which followed dealt primarily with the effect of surface oxide films and surface layers on the frictional behaviour of metals. R. Wilson (Cambridge), using electrical resistance measurements between the sliding surfaces, showed that with most metals the natural oxide layer is sufficient to prevent metallic contact at very small loads. The degree of protection depends on a number of factors, such as surface roughness and the thickness of the oxide film, and in particular on the relative hardness of the oxide and metal substrate. Dr. A. J. W. Moore and W. J. McG. Tegart (Commonwealth Scientific and Industrial Research Organization, Australia) described some experiments on a series of copper–beryllium alloys and showed that the friction decreases linearly with increasing hardness. This behaviour was attributed to the more marked plastic deformation of the softer alloys and the increased disruption of the oxide film which therefore ensued. In a second paper these authors showed that, during repeated sliding, oxide is impressed to a considerable depth beneath the surface of the metal. The included oxide particles prevent grain growth in the surface layers during subsequent annealing, and it was suggested that this process may play a part in the formation of the Beilby layer. The importance of the Beilby layer in practical bearing surfaces was stressed by Prof. G. I. Finch and Dr. R. T. Spurr (Imperial College). They showed that in many cases frictional sliding occurs between the oxide rather than the metal, and the fact that the amorphous oxide layer is in general much harder than the underlying metal means that it is better able to prevent intermetallic contact. Dr. R. Courtel (France) described electron diffraction experiments on metal surfaces prepared by grinding in a very high vacuum in the body of the diffraction camera itself. In this way the formation of the oxide film or the adsorption of fatty materials may be directly studied. In the next paper Prof. A. T. Gwathmey, Dr. H. Leidheiser and Dr. G. P. Smith (Virginia, United States) described experiments on the friction and adhesion between large single crystals of copper. When the surface oxides are removed, the coefficient of friction is extremely high ($\mu = 25$–100) and very marked adhesion is also observed.

In the last two papers in this section the mechanism of wear was discussed. Dr. E. M. Trent (Coventry) spoke on the wear of cemented carbide tools. He showed that at high temperatures tungsten carbide forms an alloy with steel so that, in the cutting of steel, tungsten carbide tools wear rapidly. Titanium carbide resists alloy formation and hence greatly reduces the wear. Prof. J. T. Burwell (Massachusetts Institute of Technology) discussed metallic wear under steady-state conditions and showed that the behaviour was consistent with the general picture of formation and shearing of metallic junctions at the regions of real contact. Under his experimental conditions the volume of material worn away was proportional to the load and the length of path traversed. The results suggest that an increase in load produces a proportional increase in the *number* of welded junctions each of which remains approximately of constant size. Above a certain load, corresponding to a mean pressure about one-third

the hardness of the pin, a very large increase in the wear is observed, due to the overlapping of the plastic regions around each junction.

In the discussion which followed, Prof. F. E. Simon (Oxford) raised some interesting points on the energetics of the frictional process, and in particular asked for a fundamental mechanism to explain the conversion of friction into heat. Mr. A. W. Crook (Associated Electrical Industries, Ltd., Aldermaston) pointed out that impact experiments on indium indicate that metallic junctions take a finite time to reach their full strength. Mr. P. P. Love (Glacier Metal Co., London) quoted some experimental results on bearing metals impregnated with polytetrafluoroethylene which ran without lubrication under conditions where conventional bearings completely failed.

Friction of Non-metals. In this section some recent experiments on the friction of diamond, graphite and carbon were described in a paper by Dr. F. P. Bowden, J. E. Young and G. W. Rowe (Cambridge). Experiments with surfaces outgassed *in vacuo* again showed a large increase in friction when the surface films were removed, but the gross seizure observed with metals under comparable conditions did not occur owing to the limited deformation at the regions of contact. Dr. K. V. Shooter (Cambridge) described a study of the frictional properties of plastics. With these materials there is a deviation from Amontons' law at low loads. Apart from this, however, the frictional properties can be explained in terms of adhesion and shearing at the interface exactly as for metals. An important exception is polytetrafluoroethylene, which on account of its molecular structure has an exceptionally low coefficient of friction. In the last paper, Prof. N. Gralén (Gothenburg) described some ingenious experiments for determining the friction between single fibres. His investigations show that, as for plastics, the coefficient of friction tends to increase at very small loads. The importance of this work in textile research was emphasized by Mrs. K. R. Makinson (Commonwealth Scientific and Industrial Research Organization, Australia).

Boundary and Extreme-Pressure Lubrication. This section opened with a survey by Dr. D. Tabor (Cambridge) of the mechanism of boundary lubrication. He showed that, although boundary lubricants enormously reduce the amount of metallic interaction, they do not eliminate it entirely. The most effective lubrication is obtained when the lubricant film is solid and possesses a close-packed structure. When the film melts, a marked increase in friction and metallic interaction occurs. For this reason fatty acids are generally more effective than hydrocarbons or paraffins, since they can react with the metal surface to form metallic soaps of relatively high melting points. These observations have been confirmed in some recent experiments using radioactive metals to detect the amount of metal transferred from one surface to the other as sliding proceeds. A new observation is that, at temperatures above the melting point of the lubricant film, a further deterioration occurs due to the desorption of the lubricant film. At this stage, although the surfaces are flooded with lubricant, the friction and surface damage are comparable with those observed with unlubricated surfaces. These changes, which are reversible on cooling, correspond to changes in state of the lubricant film. Similar changes are observed in electron diffraction studies of the structure and orientation of boundary films.

Dr. J. S. Courtney-Pratt (Cambridge) described an optical method of measuring the thickness of adsorbed layers using the Tolansky multiple-reflexion interferometric technique. The investigation showed directly that molecules of fatty acid, spread by retraction, are adsorbed on the surface as a uniform monomolecular layer. Dr. F. T. Barwell (Mechanical Engineering Research Organization, East Kilbride) discussed the effect of surface structure on the friction of metals sliding under boundary conditions. Surface roughness appears to play a small part; but work-hardening of the surface layers may produce an appreciable increase in the friction. The type of oxide film formed under various conditions may also have a marked effect. Finally, Dr. C. G. Williams (Thornton Research Centre, Chester) spoke on the action of extreme-pressure lubricants. The underlying principle is to use additives which can react with the metal surfaces to form protective films. In general, the additives are inert under less severe conditions of sliding, but at the high temperatures developed at incipient seizure rapid reaction occurs. Metal chloride and metal sulphide films are particularly effective as protective films, and for this reason a large number of extreme-pressure additives contain labile sulphur or chlorine.

In the discussion which followed, Dr. W. Hirst, M. Kerridge and J. K. Lancaster (Associated Electrical Industries, Ltd., Aldermaston) described an investigation of the thickness of the lubricant film necessary for effective boundary lubrication. Using radioactive tracer techniques they have shown that at small loads a single monolayer is sufficient, but at higher loads, where appreciable deformation of the surfaces occurs, considerably thicker films are necessary.

The full discussion will be published in the *Proceedings of the Royal Society*.

D. Tabor

OBITUARIES

Dr. J. C. E. Simpson

James Charles Edward Simpson was educated at St. Edward's School, Oxford, and the University of Liverpool. He graduated in 1929, was awarded the Leverhulme Chemistry Prize and the Campbell Brown Fellowship, and began research under Prof. (now Sir Ian) Heilbron on the chemistry of ergosterol. In 1933 the award of a Commonwealth Fund Fellowship took him to the Rockefeller Institute, New York, where he studied steroid sapogenins with Dr. W. A. Jacobs. He returned to England in 1935 and became an assistant lecturer at King's College, London, where for four years his work was mainly in the triterpene field, with particular reference to β-boswellic acid and β-amyrin.

From 1939 Dr. Simpson was a temporary lecturer in the Durham Division of the University of Durham. There he became interested in the chemistry of cinnoline, and this system was studied together with related antimalarial agents. In 1945, he was awarded the D.Sc. degree of the University of Liverpool and at the beginning of that year went as I.C.I. Fellow to the Chemotherapy Department of the Liverpool School of Tropical Medicine. Collaboration with the director, Dr. E. M. Lourie, on the chemotherapy of trypanosomiasis was continued after 1946, when Dr. Simpson was appointed to the scientific staff of the Medical Research Council. A comparative study of

a group of related heterocyclic compounds formed an integral part of this work, which was pursued after he became director of the Council's Group for Research on Chemotherapy in the Chemistry Department at Manchester. His untimely death on February 7, at the age of forty-three, came when he was starting a new programme in which his experience of natural products and synthetic work would have proved invaluable.

Besides research communications, Dr. Simpson's writings included a book on "Cinnolines, Phthalazines and Quinoxalines", an article on pterins for "Thorpe's Dictionary" and the Heterocyclic Section of the "Annual Reports" (1946); he had previously done editorial work for the Bureau of Abstracts.

Simpson was possessed of boundless intellectual and physical energy, which in research was expended without reservation on the problems in hand. Characteristically, his leisure was spent in an energetic way, fell-walking and playing tennis or badminton; he was a life-long campanologist and an active member of choral societies. His travels in connexion with these pastimes revealed a latent ability as a racing motorist. The intensive use which he made of his own time often made his conversation appear abrupt to those who were not well acquainted with his manner, but in fact he was always ready to cease work to offer help on problems in which he need have taken no interest. He will be remembered always as a loyal and generous colleague, a man of the highest calibre.

C. M. Atkinson

We regret to announce the following deaths:

Dr. A. E. Cameron, recently reader in entomology in the University of Edinburgh and formerly professor of zoology, University of Saskatchewan, on February 27, aged sixty-four.

Sir Roger Hetherington, C.B., O.B.E., chief engineering inspector, Ministry of Health, during 1930–44, and president in 1947–48 of the Institution of Civil Engineers, on February 24, aged seventy-six.

Sir Charles Sherrington, O.M., G.B.E., F.R.S., past president of the Royal Society, aged ninety-four.

Colonel E. Bright Vedder, sometime senior member of the U.S. Army Board of Research, and later professor of pathology and experimental medicine in George Washington University, known for his work on beriberi and clinical scurvy, on January 30, aged seventy-three.

NEWS and VIEWS

Chairmanship of the Advisory Council on Scientific Policy: Sir Henry Tizard, G.C.B., F.R.S.

Sir Henry Tizard will be retiring at the end of March from the Advisory Council on Scientific Policy. The Council was founded in January 1947 as a result of a recommendation of the Barlow Committee, and Sir Henry became its first chairman, a post which he filled concurrently with that of chairman of the Defence Research Policy Committee. To undertake these two tasks Sir Henry resigned from the presidency of Magdalen College, Oxford, an office which he had taken up in 1942. He brought to both posts a considerable knowledge of scientific affairs in government. From the time of the First World War he had been closely connected with the development of the scientific services of the Royal Air Force. He was chairman of the Aeronautical Research Committee during 1933–43, and a member of the Air Council itself in the earlier part of the Second World War. As permanent secretary of the Department of Scientific and Industrial Research during 1927–29, he also had a first-hand knowledge of the civil side of government science. It fell to him to establish the Advisory Council as a common meeting ground where advice to the Government on current and prospective demands for scientific workers, on the organization of government science, and on the broad allocation of our scientific resources could be formulated with the participation of the secretaries of the Research Councils, one or two scientific advisers to Ministers, and independent members drawn from among the officers of the Royal Society, the universities, and scientific men in industry. It was necessary to the Advisory Council's success that it should deal with matters of policy which could not be effectively handled by other bodies, while refraining from intervention in the numerous and important problems with which existing bodies could more appropriately deal. Sir Henry Tizard's rare capacities and experience proved equal to the task, and Prof. A. R. Todd, who follows him, will succeed to the chairmanship of a going concern with a record of achievement and with a high prestige in Whitehall. Sir Henry has now become a director of the National Research Development Corporation, and fortunately is not disappearing entirely from public life.

Prof. A. R. Todd, F.R.S.

Prof. A. R. Todd, who has been appointed to succeed Sir Henry Tizard as chairman of the Advisory Council on Scientific Policy, has been professor of organic chemistry in the University of Cambridge since 1944, an appointment to which he moved after occupying the Samuel Hall chair of chemistry in the University of Manchester during 1938–44. Prof. Todd is an organic chemist of great distinction. He has made outstanding contributions to the chemistry of complex molecules of great current interest in biology. Among his many achievements are the synthesis of vitamin B_1, and the determination of the structure and the synthesis of vitamin E. He has also made very important strides in determining the structure of such degradation products of nucleic acids as purines, pyrimidines, nucleosides and nucleotides. More recently he has turned his attention to the chemistry of the adrenocorticotrophic hormone (A.C.T.H.). Prof. Todd returns to the Advisory Council on Scientific Policy after a gap of a year, having been one of the original members appointed in 1947. Unlike his predecessor, Sir Henry Tizard, he will not leave his University but will continue to give full-time direction to his Department in Cambridge. He will be enabled to do this partly by resigning from certain other official committees and partly as a result of recent developments which have led to much of the detailed work of the Advisory Council being done by its committees under the general supervision of the whole body. Prof. Todd will also be free of the heavy responsibilities of the chairmanship of the Defence Research Policy Committee,

which took the greater part of his predecessor's time. His choice is therefore a very happy one, in so far as the benefit that the Council will derive from his able leadership will not be at the cost of a decline in his more directly scientific activities.

Vice-Chancellorship of the University of Sheffield : Sir Irvine Masson, M.B.E., F.R.S.

Sir Irvine Masson, vice-chancellor of the University of Sheffield, is retiring in September. He was born in Melbourne, the son of Sir David Orme Masson, professor of chemistry in the University of Melbourne, and it was in Melbourne that he was educated and began his chemical research. Then came study in the Universities of Edinburgh and London with Sir James Walker and Sir William Ramsay respectively ; he was appointed lecturer in chemistry at University College, London, in 1912, and reader in 1919. During the First World War, after a period of service in the R.N.V.R., he was on the staff of the Research Department of the Royal Arsenal at Woolwich. From 1919 until 1924 he was honorary secretary of the Chemical Society of Great Britain and Ireland. In 1924 he was appointed professor of chemistry and head of the Department of Science at Durham, and it was there that he carried out his investigations into nitration and the organic compounds of iodine, work which is characterized by elegance of method and profound insight into both physical and organic chemistry. He also made important contributions to the deliberations of the Royal Commission set up to consider the constitution of the University of Durham.

In 1938 Sir Irvine was appointed vice-chancellor of the University of Sheffield, and in the following year he was elected to fellowship of the Royal Society. From the outbreak of war in 1939 he acted also as director of a team of government research workers housed in the Chemistry Department at Sheffield. He served as chairman of the Amatol Committee and as a member of other committees concerned with the supply of explosives. His Service experience and knowledge of official methods derived from the First World War were of great value at this time. But in all the press of war-time activity, he never lost sight of the tasks that peace would bring, and towards the end he began progressively to detach himself so as to be fully prepared for them. The end of the War brought to Sheffield, in common with all other Universities, innumerable problems arising chiefly from the great expansion of student numbers. To the solution of these problems, Sir Irvine brought a cool judgment, a steady sense of values and strong convictions about the true nature and purpose of a university, the part which it should play in the life of the nation, and the proper standards of university work. These qualities, combined with his grasp of the details of university administration, and his mastery of the intricacies of university finance, have been of incalculable value to Sheffield, and have given weight to his counsels in the Vice-Chancellors' Committee. He received the honour of knighthood in 1950. On his retirement at the end of the present session Sir Irvine will leave behind him the record of a difficult task ably and devotedly performed.

Prof. J. M. Whittaker, F.R.S.

John Macnaghten Whittaker, professor of pure mathematics in the University of Liverpool since 1933, is to succeed Sir Irvine Masson as vice-chancellor of the University of Sheffield. Prof. Whittaker and his father, Sir Edmund Whittaker, formerly professor of mathematics in the University of Edinburgh, are both Fellows of the Royal Society. Prof. Whittaker, who was born in 1905, has written many papers on special topics in pure mathematics ; but his principal contributions to knowledge have been connected with the theory of integral functions, including the formulation of some new problems, and the theory of expansions in series of basic polynomials. He was educated at Fettes, the University of Edinburgh and at Trinity College, Cambridge. He received his first degree in Edinburgh, was awarded the Vans Dunlop Scholarship in Mathematics, and was lecturer in mathematics during 1927–29. In Cambridge he was a Scholar of Trinity College, Wrangler in the Mathematical Tripos, Smith's Prizeman, Fellow and lecturer at Pembroke College, University lecturer, and Adams Prizeman. In the University of Liverpool he was Dean of the Faculty of Science during 1947–50 and, at various times, member of a number of administrative and academic committees. He joined the Army at the outbreak of the Second World War and was a member of a group in Anti-aircraft Command charged with the scientific investigation of artillery techniques. In 1941 he was transferred to the Western Desert for an operational investigation of the use of artillery in the field. He was given the rank of lieutenant-colonel in 1944 and, during 1944–45, was deputy scientific adviser to the Army Council.

Corday–Morgan Medal and Prize of the Chemical Society

The Chemical Society has awarded the Corday–Morgan Medal and Prize for 1950 to Dr. R. S. Nyholm in recognition of his outstanding experimental work on co-ordination compounds with special reference to his discovery of tervalent nickel complexes. Dr. Nyholm, who is thirty-five years old, is an Australian and went to Britain in 1947 with an Imperial Chemical Industries fellowship which he held at University College, London. After holding a lectureship for two years at the College, he returned early this year to Australia to take up an appointment at the New South Wales University of Technology, Sydney. The Corday–Morgan award, which consists of a silver medal and a monetary prize, was instituted following a bequest to the Chemical Society by the late Sir Gilbert Morgan (president, 1933–35) ; it is made annually to the British scientific worker who shall during the year in question have, in the judgment of the Council, published the most meritorious contribution to experimental chemistry and who, at the date of publication, shall not have attained the age of thirty-six years. In order that all relevant publications may be taken into account, the award is not considered until twelve months after the end of the year in question.

Freedom of Information

In connexion with the Bill dealing with the law of libel now before the House of Commons (see p. 381 of this issue) the recent action in the Central Criminal Court against The Times Publishing Co., Ltd., is not without significance. The action was brought because *The Times* had inserted an advertisement containing a mining company's statement to its shareholders which argued against the limitations of dividends as a menace to the company's business. Mr. Justice McNair rejected the argument that the advertisement was intended to promote the election of a

particular candidate and ruled that the Crown had established no *prima facie* case; he directed the jury to bring in a formal verdict of acquittal. While common sense will applaud this result and there is reason for satisfaction that no further shackle has been placed on comment or expression of opinion, even when prejudiced, at a time of general election, the need for vigilance remains. The action has demonstrated two things. The meaning, or at least the interpretation of this section of the Representation of the People Act, 1949, relating to the incurring of election expenses is not precise. Mr. Justice McNair's decision has safeguarded the wider public interest of free comment for the present. But the action has also shown that there are parties to whom this vital national interest of free expression of opinion and comment counts for nothing against the interests of a section or a political party; the real significance of the action may well lie in its fresh warning of the need for unceasing vigilance. Powers created for the rightful purpose of preventing bribery can only too easily be used to limit debate and the free exchange of information and comment, upon which the vitality of democratic institutions depends.

Careers in Agricultural Research

A USEFUL pamphlet entitled "Careers in Agricultural Research: Training Grants, Studentships and Fellowships awarded by the Agricultural Research Council, 1952" has recently been issued by the Council (Cunard Building, 15 Regent Street, London, S.W.1). There are openings for research workers in many of the twenty-two agricultural research institutes financed by the State. In addition, certain appointments in universities and other research institutions are financed by the Council; many of these are temporary in character, but are particularly attractive to the young worker who wishes to work under the personal guidance of a distinguished scientist. The pamphlet also gives useful information about the scientific staffs of the Council and of the State-aided agricultural research institutes and about the advisory services.

This year the Council is again offering a limited number of junior agricultural research fellowships to research workers of outstanding ability. Each fellowship will be tenable for three years, at home or abroad, and has a stipend of £600 a year. Following this, if the Fellow wishes to seek an appointment with the Council, he will, if accepted, be appointed to the grade of senior scientific officer. Moreover, it is proposed to offer to graduates this year training grants and research studentships in agricultural and veterinary science. Applications must reach the Secretary of the Council by March 21. Further information and a copy of the pamphlet can be obtained on application to the Secretary of the Agricultural Research Council, Cunard Building, 15 Regent Street, London, S.W.1.

Louis Rapkine Memorial Fund

A BRITISH Working Committee, formed in 1950, has now launched an appeal for funds for the foundation of a memorial to Louis Rapkine (1904–1948), the French-Canadian biochemist. The appeal is sponsored by many distinguished men of science. Though a Canadian citizen, Rapkine did much work in connexion with hospitality in France for refugees from totalitarian countries during 1934–39. During the Second World War he organized the escape of many individuals from France and the setting up of centres in the United States and Great Britain where French scientific workers could take part in the Allied war effort. In 1946 he returned to research in cell chemistry at the Pasteur Institute; but he died two years later. A similar fund is being established in France under a French Working Committee. It is considered that the best form which the memorial could take would be an occasional lecture to be given by a young Frenchman invited by the British Committee. It is proposed that the funds raised should also be used for covering the short-term visits of young French scientists, in particular biochemists and biologists, to Britain to learn a specific experimental technique, to take part in symposia, or other similar purposes. It is understood that some of the funds of the French Committee will similarly be available for young British scientists in France. Further information can be obtained from Dr. Barbara Holmes, 32 Fulbrooke Road, Cambridge.

Scientific Film Association

THE Scientific Film Association (164 Shaftesbury Avenue, London, W.C.2) is organizing a conference on "Films can help Industry", which will be held in the Adelphi Hotel, St. Leonards-on-Sea, during April 4–6. Three films will be shown, and there will be a number of discussions, both among the conference members as a whole and in more specialized discussion groups. The fee for the conference is one guinea, and accommodation can be reserved at the Adelphi Hotel. Further information can be obtained from the conference secretary, Mr. J. Le Harivel, at the Association. The Association is also showing a number of scientific and technological films at 7.45 p.m. on March 20 and March 22 at the cinema of the French Institute, Queensberry Place, London, S.W.7. Sixteen films will be shown, nine on the first night and seven on the second, and they are drawn from the following eleven countries: Australia, Belgium, Canada, France, Germany, Great Britain, Hungary, Netherlands, New Zealand, United States and the U.S.S.R. Tickets of admission, 2*s*. 6*d*. each session or 4*s*. 6*d*. for both (2*s*. and 3*s*. 6*d*. to members of the Association) are obtainable from the Association.

International Congress on Analytical Chemistry at Oxford

AN International Congress on Analytical Chemistry, to be held under the patronage of the International Union of Pure and Applied Chemistry, will take place at Oxford during September 4–9; meetings of the board and commissions of Section 5, the Analytical Chemistry Section, of the International Union of Pure and Applied Chemistry, will probably be held on September 3 and 10. The president of the Congress will be Sir Robert Robinson, with Sir Wallace Akers as vice-president. The Congress will be divided into nine sections, based broadly on techniques as follows: microchemical, biological, electrical, optical, radiochemical, organic complexes, reporting of results, adsorption and partition methods, and miscellaneous techniques. Papers will be issued in preprint form, and authors will give only a brief introduction so as to allow most of the time for discussion, thirty minutes being the maximum time allowable for each paper. The official language of the Congress will be English; it is permissible to submit a paper in French or German, but in this case summaries must be given in each of the other two languages. During the Congress three main lectures

will be given by Prof. C. J. van Nieuwenburg, professor of chemistry in the Technical University of Delft; Dr. Ralph H. Müller, Los Alamos Scientific Laboratory, New Mexico; and Dr. L. H. Lampitt, chief chemist and director of J. Lyons and Co., Ltd. The whole of the proceedings will be published as soon after the Congress as possible, in a special number or numbers of the *Analyst*. In addition to these events, there will be a number of working demonstrations on new developments in analytical chemistry, and also a trade exhibition of apparatus and books. Further particulars and application forms (to be returned by March 31) can be obtained from the honorary secretary, R. C. Chirnside, Research Laboratories, General Electric Co., Ltd., Wembley, Middlesex.

Radiation Chemistry: Faraday Society Discussion at Leeds

The Faraday Society is organizing a general discussion on "Radiation Chemistry", to be held in the Department of Chemistry, University of Leeds, during April 8–10. Sir Charles Goodeve will be in the chair, and Prof. F. S. Dainton will give a general introduction. Topics to be discussed include: mechanism of energy loss by fast charged particles; theory of stability of molecular ions, charge neutralization and electron capture processes; radiation actinometry; direct action in one-component systems; radiolysis of water and other pure liquids; indirect action in aqueous systems containing a single solute; multi-solute systems, including protective effects and sensitization; other solvents. Papers will be printed in advance and it is hoped to circulate proofs by about March 18. Accommodation is available in the University, and application must be made, to arrive not later than March 28, to the Assistant Secretary, Faraday Society, 6 Gray's Inn Square, London, W.C.1, from whom all further particulars can be obtained.

Geographical Association

The spring conference of the Geographical Association will be held in Tenby, with headquarters at the Little Theatre, during April 18–22. Lectures will be given by Prof. E. G. Bowen (University College, Aberystwyth); Prof. D. L. Linton (University of Sheffield); Mr. H. Carter (University College, Aberystwyth); Sir Frederick Rees (formerly of University College, Cardiff); and Prof. H. C. Darby (University College, London). Further details can be obtained from the honorary conference organizer, W. S. Moss, Trinity College, Carmarthen. The Association is also organizing a summer school for field-work in geography, designed especially for teachers, which will be held at Coleg y Fro, Rhoose, during August 2–16. The fee for the school will be £16 per person, and numbers will be limited to sixty. Further information can be obtained from the Assistant Secretary, Geographical Association, Park Branch Library, Duke Street, Sheffield 2.

University of Leeds

The following appointments have recently been made in the University of Leeds: I. M. P. Dawson, lecturer in pathology; C. O. Carter, part-time medical geneticist; J. O. Myers, lecturer in mining. The title and status of reader in physico-chemical aspects of biochemistry has been conferred upon S. Dagley, lecturer in the Department of Biochemistry.

The following bequests, among others, have recently been made to the University: to the Department of Biomolecular Structure, £3,000 over two years from the Nuffield Foundation, for infra-red research; to the Department of Inorganic and Physical Chemistry, £700 from the Anglo-Iranian Oil Co., Ltd., for research by Prof. F. S. Dainton, and £600 from Monsanto Chemicals, Ltd., for 1951–52; to the Department of Textile Industries, £6,000 from the Wool Textile Research Council to purchase an ultra-centrifuge from the United States; and to the Department of Mining, £1,200 from the National Coal Board for research into geophysical methods for determining depth of superficial deposits.

Announcements

Prof. W. T. Astbury, professor of biomolecular structure and honorary reader in textile physics in the University of Leeds, will deliver the Mather Lecture for 1952 of the Textile Institute. He will speak on "The Great Adventure of Fibre Structure", and the lecture will follow the Institute's annual meeting to be held in the University of Leeds on April 30.

Sir Guy Marshall, chairman of Pest Control, Ltd., since its foundation in 1939, has resigned for reasons of health. He will be succeeded by Lord Boyd-Orr, sometime director-general of the United Nations Food and Agriculture Organization.

Dr. A. David, formerly of Pest Control, Ltd., has been appointed chief pharmacologist to the British Drug Houses, Ltd., London.

Two Ramsay Memorial Fellowships for chemical research, worth £400 a year with a grant for expenses not exceeding £100 a year, and tenable normally for two years, are being offered to mark the centenary of the birth of Sir William Ramsay on October 2, 1852. The necessary funds have been provided by Messrs. British Celanese, Ltd., and the Association of British Chemical Manufacturers. Further information can be obtained from the Joint Honorary Secretaries, Ramsay Memorial Fellowships Trust, University College, Gower Street, London, W.C.1, to whom applications must be forwarded not later than April 17.

The Medical Research Council, by arrangement with the Centre National de la Recherche Scientifique, is offering two scholarships, worth 45,000–90,000 francs a month plus marriage allowance, which are open to British graduates for research in medical science, excluding clinical medicine, to be conducted at research institutions in France during the academic year 1952–53. Candidates should have had some previous research experience and must possess a working knowledge of French. Application forms, obtainable from the Secretary, Medical Research Council, 38 Old Queen Street, London, S.W.1, must be completed by March 31.

The Unesco South Asia Science Co-operation Office, Delhi, has issued No. 4 of the Bibliography of Scientific Publications of South Asia (pp. 86, 1951), covering periodicals of India, Burma and Ceylon received during the period July–December 1950. As before, titles are entered under main classes of the Universal Decimal Classification, and there is a supplementary list of periodicals, giving new periodicals, by country, and changes of name or address or notice of discontinuance of publication. There are 2,172 titles listed.

VEGETATIVE GROWTH OF THE POTATO PLANT

By C. E. TAYLOR

Department of Agricultural Sciences, University of Nottingham School of Agriculture, Sutton Bonington

RECENT studies on the growth of potato plants in Australia by Bald and Hutton[1] indicate that all varieties of potatoes grown under identical conditions are likely to show similar growth-rates during the early stages of vegetative development. Earlier, Bald[2] had propounded a general plan of growth for the potato plant founded on the principle of competition for the available metabolites between the various organs of the plant. The first stage of growth is identified as that in which the major portion of the metabolites are used for the extension of the main shoot and the expansion of the attendant leaves, so that it is to be expected that during this period of development all potato varieties will have similar growth-rates. Varietal differences are manifested at the beginning of the second stage of development, which opens with the beginning of rapid development of axillary shoots above ground, or stolons below, and ends when the plants attain their maximum leaf area.

Observations were made on seven potato varieties during 1950 and 1951 at the University of Nottingham School of Agriculture, Sutton Bonington, Loughborough, in connexion with research into the establishment and development of aphid colonies in relation to the physiology of the potato leaf. In view of the fact that little additional information appears to be available on the development of the vegetative phase of the potato plant, an outline of the data obtained with the 1951 experiments, in which five varieties were planted on the same date in a Latin-square layout, is given here. Samples of leaves were taken from five different zones on the plant (except during the early stages of growth), basal, lower, middle, upper and apical zones being identified according to the development of the leaf and its position in relation to the main shoot. Direct measurements, by means of a specially constructed graticule, were taken of the areas of leaves taken as random samples from each zone.

MEAN LEAF AREA (LOG_{10} VALUES) PER PLANT FOR FIVE VARIETIES OF POTATO

Variety	Stormont Dawn	Majestic	King Edward	Arran Pilot	Ulster Chieftain
Mean date of emergence	16.5.51	18.5.51	18.5.51	11.5.51	12.5.51
Date of sample					
1.6.51	2·94	2·85	2·84	3·06	2·87
10.6.51	3·30	3·18	3·16	3·35	3·19
20.6.51	3·57	3·51	3·45	3·64	3·47
4.7.51	3·89	3·81	3·80	3·84	3·78
18.7.51	4·22	4·14	4·13	4·07	4·07
23.7.51	4·26	4·23	4·17	4·15	4·10
30.7.51	4·45	4·45	4·33	4·28	4·12
19.8.51	4·26	4·11	4·22	4·25	4·03

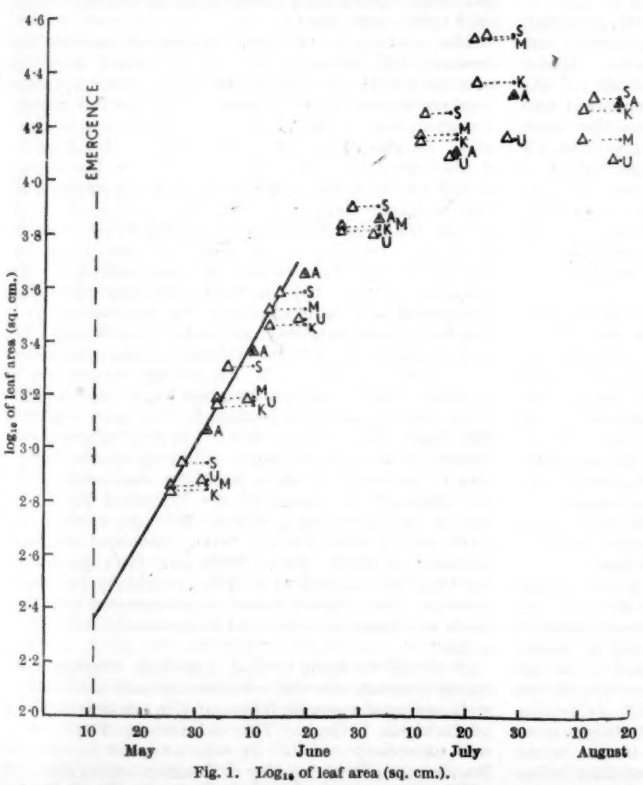

Fig. 1. Log_{10} of leaf area (sq. cm.).

Growth in leaf area of potato plants represented as *K* (King Edward), *M* (Majestic), *S* (Stormont Dawn), *A* (Arran Pilot), and *U* (Ulster Chieftain). Positions on the time-scale are corrected for emergence by shifting the values for a variety back according to the mean number of days after May 11 (the emergence of Arran Pilot) that the variety emerged; transposed values are indicated by triangles

During the first stage of development of the plants, before the formation of axillary shoots, the rate of increase in total leaf area for each of the varieties was very nearly equal. The plants not only grew at the same rate, but also, with the exception of the variety "Ulster Chieftain", were of about the same leaf area at any given time after the recorded date of emergence. "Ulster Chieftain", a low, compact grower with comparatively few leaves, from the first sampling date had smaller haulms and soon attained its maximum leaf area. This level was maintained, however, during the period in which other varieties continued to increase in size.

Soon after the initiation of axillary shoots, differences in growth-rates became apparent. The main-crop varieties observed, namely, "Majestic", "King Edward" and "Stormont Dawn", continued to increase in leaf area to their maxima, whereas "Arran Pilot", an early variety of medium height, reached

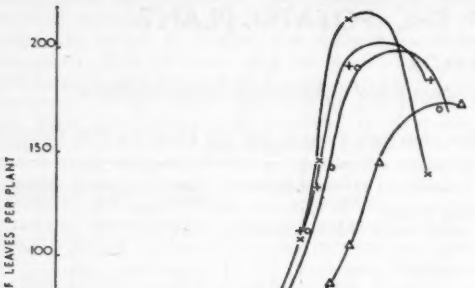

Fig. 2. Number of leaves per plant
△ Arran Pilot; □ Ulster Chieftain; × Majestic; ○ Stormont Dawn; + King Edward
The time-scale represents the number of days from the mean emergence-date for each variety

its peak size at an earlier date than these, although it had a relatively longer static period while the foliage area remained at a steady level. "Ulster Chieftain", an early potato, was the first (of the varieties studied) to attain its peak size, but it had a static period considerably longer than the other varieties. Thus if changes in vegetative growth are taken as a general indication of the distribution of the available metabolites in the plant, "Ulster Chieftain" would, as is in fact the case, be expected to begin tuber formation somewhat earlier in the season than "Arran Pilot", the latter being followed by the maincrop varieties "Majestic", "King Edward" and "Stormont Dawn".

Each variety differed in the number of leaves produced per plant and in the maximum size of the individual leaves. "Ulster Chieftain" appeared to have a slower rate of leaf production from the start of vegetative growth, but the individual leaves were relatively larger and thus the rate of increase in leaf area appears the same as in other varieties. "Arran Pilot" produced leaves at the same rate as the maincrop varieties during the initial phase of growth, but later this rate decreased with the commencement of tuber formation. "Majestic", "King Edward" and "Stormont Dawn" produced leaves at approximately the same rate throughout their growing period.

It is probable, therefore, that the potato plant exhibits a basic growth-form which is modified in each variety in a characteristic manner according to the stage in the growth-cycle and the rate at which the growth substances are distributed to the various organs. Some varieties use a high proportion of the available metabolites for the production of tubers early in the season, showing a correspondingly slow growth of shoots from the axils of the leaves, while opposed to these are varieties which form their tuber initials considerably later but which show a continuing rapid differentiation of axillary shoots above ground. Modifying this varietal growth-form, as manifested by increase in total leaf area, are such factors as time of planting, type of seed, and environmental conditions (including light, temperature, rainfall and soil conditions), which have been shown to affect the growth-rate of the plant to some degree[3-5].

The help of Mrs. N. McDermott and Mr. J. D. Ivins, of the University of Nottingham School of Agriculture, is gratefully acknowledged. [Oct. 4.

[1] Bald, J. G., and Hutton, E. M., *Aust. J. Agric. Res.*, **1**, 3 (1950).
[2] Bald, J. G., *Emp. J. Exp. Agric.*, **14**, 43 (1946).
[3] Glover, J., *Emp. J. Exp. Agric.*, **15**, 9 (1947).
[4] Werner, H. O., *J. Agric. Res.*, **64**, 257 (1942).
[5] Van Der Plank, J. E., *Emp. J. Exp. Agric.*, **14**, 217 (1946).

GWYNNE-VAUGHAN RESEARCH LABORATORY, BIRKBECK COLLEGE, LONDON

ON January 31 at Birkbeck College, University of London, the new Gwynne-Vaughan Research Laboratory was opened by Dame Helen Gwynne-Vaughan. The Laboratory commemorates the first two full-time heads of the Department of Botany in the College. D. T. Gwynne-Vaughan (1871–1915) was appointed in 1907 and accepted the chair of botany in the University of Belfast in 1909. He was succeeded by Dr. H. C. I. Fraser, whom he married two years later; with two periods of war service she held office until 1944.

The opening of the new Laboratory provides an occasion for reflexion for the botanists, scattered over the world, who were trained by the distinguished workers whose names it bears. Prof. D. T. Gwynne-Vaughan was an anatomist whose work is now classical: he was particularly interested in the Filicales. A photograph on the wall of the new Laboratory shows him at work with Dr. F. Kidston on the fossil Osmundaceæ and recalls the words of Prof. F. O. Bower that, in the series of papers which resulted from that happy co-operation, "seldom have two minds blended their results more effectively". The memory of Prof. Gwynne-Vaughan's personal charm, kindliness and humour, and his distinction as a teacher, as well as a research worker, is still very vivid in the minds of his former colleagues and students.

In 1909 Dr. H. C. I. Fraser was appointed to succeed Prof. Gwynne-Vaughan, and she brought great dignity and distinction to the post. During the First World War, Mrs. Gwynne-Vaughan was posted to France as senior officer of Queen Mary's Army Auxiliary Corps; later she was sent to the Air Ministry in charge of the Women's Royal Air Force. She received a D.B.E. (Military Division) in 1919 and a civil G.B.E. "for public and scientific services" in 1929. From 1939 until 1941 she was at the War Office as director of the Auxiliary Territorial Service. Dame Helen has thus interspersed academic work of distinction with public service of the highest order.

It would be hard to find a greater contrast than exists between the old laboratories and the modern well-equipped research laboratory in the new building of Birkbeck College. The old Botany Department was extremely small. It was situated in Breams Buildings right in the city of London—the pulsations of Fleet Street on one side and the begrimed though quiet old-world, miniature gardens of Fountain Court and Staple Inn on the other. Classes were held in the evenings and on Saturday mornings. No ray of

sunlight ever penetrated the gloom; the research laboratories consisted of odd bits of passageway and the top of a proscenium arch, cut off for the acoustic conveniences of the hall below. Printing presses in the adjoining buildings clanged the harder as week-end editions became due, dust seeped in through every crevice and no plant had the least chance of survival, unless it was a fungus safely enclosed with all its requirements in a Petri dish.

Despite the handicaps, the students who arrived from all over the Greater London area, and indeed from beyond the seas, developed enthusiasm for their work and a great affection for the Department. They carried out publishable work on a variety of topics but predominantly on either cytology or the fungi. Many of them could only hope to attain academic distinction by way of evening classes because they were fully employed all day or were unable to pay the higher fees which would have been involved elsewhere. The full-time staff working under Dame Helen was small; but it was augmented in the evenings by botanists distinguished in their own fields, who came and gave specialist courses. To us all, teachers and taught, Dame Helen was a continual source of stimulus and inspiration. She never spared herself physically and carried out her distinguished researches on the fungi, while taking the very keenest interest in her staff and students, both past and present.

Those who best knew the old building will be the first to wish that the new Laboratory, with all its facilities, may create for itself an even greater tradition, built on the solid foundation of its inheritance and under the guidance of Prof. T. Ingold, the present holder of the chair. LILY NEWTON

INDIAN OILS AND FATS AND THEIR UTILIZATION

A SYMPOSIUM on "Indian Oils and Fats and their Utilization" was held at the National Chemical Laboratory of India, Poona, during November 7–9, 1951. Prof. J. W. McBain, director of the Laboratory and chairman of the Vegetable Oils Committee, presided.

The scope of the symposium was explained by its organizer, Dr. J. S. Aggarwal, in charge of the Oils and Fats Section of the Laboratory. He said that India is the biggest oil-seed producing country in the world, and she contributes about 20 per cent of the world's production of oil seeds. Kamla oil, which in certain respects is better than non-available tung oil, is a great potential material resource of India. Pisa fat, which is almost pure trilaurin, is perhaps available only in India, but is likewise completely neglected commercially. India's large production of many oil seeds has led to industries such as seed crushing, soap and glycerine, paints and varnishes and vanaspati. Although India is almost self-sufficient as regards these commodities, there is a great shortage of oils and fats. Other industries such as vegetable oil lubricants, greases, stearic and other fatty acids and other derivatives should also be developed. Dr. Aggarwal then suggested various methods for removing the shortage of edible oils, by increasing the overall output of oil seeds, adoption of solvent extraction, increased production of fish oils, and development of a flourishing dairy industry.

Dr. S. A. Saletore, assistant director, Central Laboratory for Scientific and Industrial Research, Hyderabad, then gave a brief report of the Oils and Fats Symposium that was held at Hyderabad during August 12–18, 1950. Altogether, seven papers on different subjects connected with oils and fats were read and discussed at that time.

At the present symposium, forty-eight papers were read and discussed under the following seven sections: (1) oil seeds and vegetable oils; (2) oil extraction; (3) soap and glycerine; (4) hydrogenation of oils; (5) fish oils; (6) castor oil, drying oils, paints and varnishes; (7) analytical and other miscellaneous papers.

(1) Oil Seeds and Vegetable Oils

Mr. I. M. Qureshi, sylviculturist, Bombay State, Poona, in his paper on "Forest Oil Seed Wealth of Bombay State", discussed the methods of increasing the yields of forest oil seeds. A survey of such forest oil-bearing plants as kamla, pisa, butter trees and others is essential. Mr. R. C. Shrivastava, agricultural chemist, Madhya Pradesha, Nagpur, spoke on "Gokhru as a Source of Vegetable Oil". One acre of land can give 500–600 lb. of gokhru seeds containing 30–33 per cent semi-drying oils. The seeds can be removed from the thorny cover by shaking in 1·5–2 per cent sulphuric acid. The cake has a high content of phosphorus and nitrogen.

Mr. S. C. Gupta (National Chemical Laboratory) gave information about the availability of kamla seeds from the forests of the Punjab, U.P., Bihar, Bengal and Bombay States. The various characteristics of the seed oil and the constitution of kamlolenic acid, the new hydroxy fatty acid constituent isolated from the oil, were discussed. Utilization of kamla oil in air-drying wrinkle finishes and for other coating materials and the prospective uses of the hydrogenated kamlolenic acids were described. The cake is a rich source of nitrogen.

In a paper entitled "Utilization of Nim Oil", Mr. C. R. Mitra (National Chemical Laboratory) discussed the various aspects of industrial utilization of the oil on the basis of the researches carried out under the Council for Scientific and Industrial Research. The process of cold alcohol extraction of the oil ensures separation of the bitter constituents and their eventual utilization in pharmaceutical industry, and at the same time leaves the oil to be utilized for production of oleic and stearic acids. The extracted oil, when refined, is as good as any other vegetable oil and can be hydrogenated, when it may be put to various industrial uses, for example, high-grade soaps or high-melting sterin.

Dr. J. G. Kane, Department of Chemical Technology, University of Bombay, pointed out the drawbacks of mowrah oil for edible purposes. These are high acidity, deep colour, unpleasant smell and high unsaponifiable matter. Alcoholic refining was found to be good. By hydrogenation, products similar to mutton tallow and coco-butter could be obtained.

Mr. T. V. Rao directed attention to the catastrophic increase in the prices of oils and fats compared to those of the United Kingdom, especially that of coconut oil. Difficulties in the way of soap and vanaspati industries were discussed and some remedial measures suggested.

Mr. P. K. Patnaik, special officer, Oil Co-operative, Government of Orissa, read an interesting paper on

"Oil and Allied Industries in the Future Development of India". In it he pointed out that though India leads the world in the production of oil seeds, the *per capita* consumption of fats and soaps is the least. In view of the many applications of oils and their products for nutrition, sanitation, protection against corrosion, medicine, lubrication, etc., this industry should receive special priority in the country's industrialization programme.

Shri Devendra Kumar Gupta, representative of the Akhil Bharat Sarva Seva Sangh, Wardha (M.P.), in his paper on the "Rational Utilization of the Oil Seed Wealth of the Country", pointed out that oils and fats are primarily meant for edible purposes. The seeds deteriorate and loss occurs during transport from villages to the big oil mills in the cities. The oil should, therefore, be extracted only in the villages in ghannies. He also demonstrated a model of the improved Wardha ghannie.

Mr. Om Prakash, oil expert to the Utter-Pradesh Government, brought to the notice of the audience that the Utter-Pradesh is the biggest mustard-seed producing State in India and it exports a large amount of this oil to other States of the country; but on account of different specifications adopted by the various States, it is difficult for the trade to sell the oil. He stressed the necessity for uniform specification of this and other oils throughout India.

Shri Tulsidas M. Vishram, hon. secretary, Oil Merchants Chamber, Bombay, in his paper on "Trading in Vegetable Oils in India and its Future", described the great wastage of oils in transit due to leakage of the containers. He pressed for the production of a better and cheaper type of container. The other difficulty has been the different weights and measures in different parts of the country.

Mr. Krishan Gopal Mathur, chief chemist, Kusum Products, West Bengal, gave a very lucid description of the refining of vegetable oils as employed in India in industry.

(2) Oil Extraction

The paper of Mr. G. V. Datar, assistant engineer, Vill. Ind. Expt. Workshop, Poona, on "Nutan Ghannie", discussed various improvements in village ghannies, which resulted in Nutan ghannie now being available for introduction in Bombay State.

Dr. K. S. Murthi, principal, Oil Technological Institute, Anantapur, in his paper discussed the necessity of cotton-seed oil milling and refining in India. A paper on the "Prospects of the Oil Milling Industry in India" was also read and discussed by Shri Vallabhdas V. Mariwala, vice-president, Oil Merchants Chamber, Bombay.

The necessity, economics and description of the solvent extraction process were very vividly and clearly discussed by Mr. H. V. Parekh, engineer, Bhavnagar Chemical Works, Ltd., Vartej (Saurashtra), Dr. N. G. Chatterji, manager, Hindustan Development Corporation, Ltd., Calcutta, and Mr. L. W. Richards, Bamag, Ltd., Bombay (read by Dr. R. J. Rathi, Poona).

In the absence of Mr. J. P. Verma (National Chemical Laboratory), his paper on "Extraction of Castor Oil through Aqueous Medium" was read by Dr. S. L. Shastry, who had carried out the large-scale experiments. With the aid of certain chemicals, castor oil in very good yield can be obtained from seed meal by heating with water. The characteristics of the oil are identical with those of ordinary castor oil.

Mr. T. K. Nayar, representative, Burmah Shell, reported the availability of petroleum solvents for oil extraction in India. A special solvent, Pegasol 1222, was also reported to be available from M/s Standard Vacuum Oil Co., Bombay.

(3) Soap and Glycerine

Dr. Ing. B. P. Godrej, director, Godrej Soaps, Ltd., Bombay, in his paper on "Commercial and Economic Aspects of Indian Soap Industry", pointed out that though the major soap producers have well-equipped plants, the high prices of oils (especially coconut and mahua) reduce the profits to almost nothing. The production of caustic soda is still not sufficient in the country. The various other economic aspects were also discussed.

A very informative paper on the use of non-edible oils in soap-making in India was presented by Mr. G. Ford and Dr. G. S. Hattiangadi, of Lever Brothers (India), Ltd., Bombay. Linseed, mowrah and castor oils, rosin, soap stock and acid oil are the chief non-edible raw materials used in India. However, these are not being produced commercially. The non-availability of the seeds and their uneven quality, etc., are the chief difficulties.

Dr. N. N. Godbole, director of industries and commerce, Rajasthan, Jaipur, discussed sweating in soaps and remedies for preventing it. He stated that some cheap oils such as karanja, neem and others had been used in the production of soap; but after some time, the soap became discoloured and hence could not be sold. Naturally, these defects should be remedied. Mr. G. M. Kelkar, in charge of village industries, Research Laboratory, Poona, exhibited samples of soaps made from the above oils.

The paper on the "Refining of Glycerine by Ion Exchange Resins" by Dr. H. A. Shah (National Chemical Laboratory) stated that soap-lye or crude glycerine contains as impurities mostly sodium chloride and organic colouring matter. This can be purified by passing it through a column of cation and anion exchange resins. Glycerine of sufficient purity for most applications may thus be obtained by simply concentrating the treated lye.

(4) Hydrogenation of Oils

Dr. M. Damodaran, assistant director, National Chemical Laboratory, gave a very informative talk on the nutritional value of vanaspati, reporting that as a result of the work carried out at four research centres in India, it has definitely been established that vanaspati is as good in nutrition value as any other fat, if its melting point remains below the human body temperature.

Mr. A. E. Shohet, the Hindustan Vanaspati Manufacturing Co., Ltd., Bombay, gave a brief survey of the vanaspati industry in India. The development of the industry, capital invested, contribution of this industry to the State exchequer, consumption of butter and ghee and vanaspati in India and other countries, specifications for vanaspati, etc., were described.

In his paper on "A Study of Catalysts in Vanaspati Production", Mr. D. D. Nanavati, chief chemist, Palanpur Vegetable Products, Ltd., Gujrat, stated that the production of vanaspati with the physical characteristics of ghee depends upon the catalysts. The various methods of reduction of the nickel catalyst for use in the hydrogenation industry were very clearly described.

Dr. R. K. Trivedi, industrial chemist, Itraco, Ltd., Bombay, described by means of a diagram the high-pressure technique employed in fat splitting in the industry and its advantages over other known methods. A description of the process for hydrogenation of the fatty acids to give higher aliphatic alcohols was also given.

(5) Fish Oils

The one paper in this section was from Mr. S. M. Arsiwala, Department of Fisheries, Bombay, on "Shark Liver Oil Industry in India". Vitamin contents of various fish oils, method of extraction of the oil, concentration of vitamin A, the capsulating process, and importance of vitamins were all indicated. Besides its medicinal value, low-grade oil is used in industry in leather tanning, manufacture of paints, varnishes, printing inks, oil cloth and linoleum. Livers of sharks are also found to be very rich in anti-anæmic factors.

(6) Castor Oil, Drying Oils, Paints and Varnishes

Dr. K. T. Achaya, Central Laboratories for Scientific and Industrial Research, Hyderabad, read a paper on "Some Investigations on Hydroxy Oils, particularly Castor", in which he suggested that the refractive index should be made the basis of evaluation of hydroxy oils and acids. Methods for the concentration of tri-ricinolein, preparation of pure ricinoleic acid and sodium ricinoleate from castor oil were briefly described. A method for analysis of hydroxy fatty oils using ester fractionation was illustrated.

Prof. K. K. Dole, professor of chemistry, Fergusson College, Poona, reported that some sulphonic acids and their salts have been found to be effective catalysts for the dehydration of castor oil. A process of rapid continuous dehydration of the oil by the use of certain catalysts was also demonstrated. Mr. M. A. Sivasamban, Central Laboratories for Scientific and Industrial Research, Hyderabad, gave a brief report of his work on the use of local clays for dehydration of castor oil. The presence of a small amount of sodium bisulphate used with the clays was found to be more effective. Conditions were also worked out for dehydration on a pilot-plant scale.

Mr. R. K. Banerji, Murarka Paints and Varnish Works, Ltd., Calcutta, and a representative of the Paint Manufacturers Association, gave a brief description of his work on synthetic drying oils obtained by the condensation of the fractions of petroleum oils and higher aliphatic alcohols.

Dr. S. A. Saletore, in his paper on "Drier Effects on Drying of Oil Films", reviewed the earlier work on dryer action. Three phases in the absorption of oxygen by linseed oil at 96° C. in presence of lead and cobalt dryers were discussed. The effects of a number of organic compounds in the drying of oils were also included.

Mr. P. G. Sharma gave a brief review of the extensive work carried out in the National Chemical Laboratory on the utilization of tobacco seed oil in surface coatings, as in paints and varnishes, after isomerization, air-drying wrinkle finishes, preparation of alkyd resins, and its metallic salts after polymerization. Other possible uses of the oil, such as the formation of factice, illuminant and for edible purposes, were also discussed.

Mr. H. H. Mathur described the work done in the National Chemical Laboratory on the employment of cashew shell liquid for surface coatings.

Dr. D. J. Mehta (National Chemical Laboratory) then reported briefly on his research work on the employment of vegetable oils for the preparation of alkyd resins from tetrachlorophthalic anhydride. These materials can be used in fire-retardent paints. Mr. Om Prakash also gave a brief summary of the work carried out at the H.B. Technological Institute, Kanpur, on the use of vegetable oils such as linseed and castor oils for modified alkyd resins.

(7) Analytical and Other Miscellaneous Papers

Dr. N. N. Godbole, in his talk on the analysis of butter fat, stressed the importance of the butyric acid number. He said that the *A* and *B* values of the butter fat are more accurate than other values such as Reichert–Meissel and Polenske values of such fats. The acetyl value of the butter fat is also found to increase with time. Dr. S. S. Gupta (National Chemical Laboratory) gave a brief survey of recent advances in the analysis of oils and fats, such as the preparation of fatty acids and glycerides by low-temperature crystallization technique and utilization of ultra-violet spectra in the analysis of various unsaturated fatty-acid mixtures. The description of the former process and its utilization in the industry in other countries was a subject of another paper by Dr. C. B. Patel, Industrial Research Laboratory, Department of Industries, Bombay. Limitations of the low-temperature crystallization technique were also discussed. In the absence of the author, the paper was read by Mr. H. H. Mathur (National Chemical Laboratory).

Dr. A. R. S. Kartha, Maharaja's College, Eranakulam, then gave a brief report of his work on "Recent Advances in the Study of Glyceride Composition of Natural Fats", which led ultimately to the development of acetic acid–acetone permanganate oxidation of fats and separation by magnesium salts of the azelo-glycerides. Another paper by the same author was on "Some Regularities in the Melting and Solidifying Points of Mixtures of GS_2 with non-GS_2 Glycerides and of Saturated with Unsaturated Fatty Acids". A simple mathematical rule was found to hold good in these cases. The various implications of these rules were also discussed.

Mr. V. S. Govindarajan (National Chemical Laboratory) gave a brief review of the application of different chromatographic procedures in the analysis of fatty oils and fatty acids. The usefulness of the process in the separation of pure fatty acid from the mixture and for the isolation of hydrocarbons from triglycerides was also discussed.

Mr. S. C. Sethi then gave a short account of the work carried out at the National Chemical Laboratory on the stabilization of edible fats by spices and condiments.

Dr. J. W. Airen, professor of chemistry, Wilson College, Bombay, briefly described his work on the analysis of carilla oil and the formation of its gel on keeping. On further storage the gel is retransformed into a viscous liquid.

Dr. B. R. Y. Iyengar (National Chemical Laboratory), in his paper on the "Application of Electrical Testing Methods in the Processing of Oils", stated that a study of the electrical properties, such as the dielectric constant and the dielectric loss, can serve as a means of following and controlling the extent and the nature of the processing of oils. Reactions like oxidation, polymerization, etc., can be followed with a rapidity unattainable by the normal time-consuming chemical methods.

The last paper on the programme was "Vegetable Oils as Petroleum Products Substitute", by Dr. M. L. Khanna, National Physical Laboratory, New Delhi. The paper was read by Mr. A. S. Gupta (National Chemical Laboratory). It described the work carried out by the Council for Scientific and Industrial Research on the utilization of vegetable oils as lubricants and diesel fuels. These oils can also be used for lubricating greases.

It was tentatively decided that the Symposium on Oils and Fats will be held next year at Bombay under the auspices of the Oil Merchants Chamber, though a warm invitation had also been received from the Oil Technologists Association, Kanpur.

J. S. Aggarwal

NEW ZEALAND DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH

ANNUAL REPORT FOR 1950–51

THE twenty-fifth annual report* of the Department of Scientific and Industrial Research, New Zealand, covers the year ended March 31, 1951, and includes the Minister's statement, the Secretary's report and the reports from the branches, research committees, research associations, etc. The net expenditure for the year was £903,550, of which £316,296 was incurred in research investigations, £184,318 for the Dominion Physical Laboratory, £127,740 for the Dominion Laboratory, £78,933 for the Geological Survey, and £57,355 for the Information Bureau, Scientific Liaison Services and miscellaneous services. Grants to universities and agricultural colleges amounted to £35,538, and to research associations to £25,959. Of a total staff of 1,010, there were 386 professional and 450 technical officers.

During the year the Department's activities in geophysics were grouped under a Geophysics Division, and a major activity of the year was the search for suitable geological structures in the Wairakei thermal region which will enable the geothermal steam and hot-water resources of the area to be utilized for power and industrial purposes. Although good progress has been made in the exploratory work, much further research will be required before utilization is possible. In association with the Geological Survey and the Geophysics Division, Dr. E. Lehner, consultant to the Anglo-Iranian Oil Co., examined all likely petroliferous regions, and his report on their potentialities as sources of petroleum is under consideration. The Secretary's report also emphasizes the economic value of some of the research findings of the Department. Thus the persistent efforts of the Botany, Soil, Plant Diseases and Entomology Divisions have now defined the dreaded yellow-leaf disease of phormium as a virus disease transmitted by the insect *Oliarus atkinsonii*, thus clarifying the attack on the problem by plant breeding and management practices. Studies of the New Zealand grass-grub, which causes very serious losses annually, have shown how this pest can be controlled economically with DDT and 'Gammexane'. Research on varieties, diseases and fertilizer treatment of the tobacco crop have contributed to an increase in average yield of dried leaf per acre from 659 lb. to 1,155 lb. in four years, or £74 8*s.* per acre at the current basic average price of leaf.

The researches of the Fats Research Laboratory and the Dominion Physical Laboratory have contributed to the establishment of a fish liver-oil industry worth £200,000 annually and utilizing material previously neglected. Pasture research at the Grasslands Division has yielded strains of grasses and clovers and a system of management enabling the production of 12–16 thousand lb. dry matter per acre annually. Since a figure of 4,000 lb. is required to yield 200 lb. of butter-fat per acre, the potential value of this increase to the New Zealand butter industry is obvious. The value of short-rotation ryegrass seed developed by this Division is estimated at £150,000 annually over the last three years, apart from the grazing value of the ryegrass. Disease control investigations by the Plant Diseases Division are estimated to have effected annual savings of £250,000 to the grazier through reduced losses in dry rot of swedes; control of mealybug of glasshouse grapes with DDT has yielded annual savings of £18,000 and of eelworm and verticillium wilt of tomatoes in Auckland glasshouses, £80,000. The savings effected in interior renovations of plaster-lined houses by control of black-mould are estimated at £42,000 annually.

From the reports from branches, only a few points can be selected for mention. Meat research on production of dehydrated meat in large-sized pieces with a more acceptable texture than mince has yielded a product with a well-distributed moisture content, of acceptable appearance and palatable when cooked, and a pilot plant is projected. The study of resinous constituents of exotic pines was continued in co-operation with the New Zealand Forest Service. The programme of simultaneous measurements of absorption of radio waves reflected by the ionosphere obliquely (in passage between Awarua and Lower Hutt) and vertically (at Christchurch) was completed. In the Fats Research Laboratory it has been established that the more highly unsaturated acids are important in connexion with the onset of rancidity in butter-fat, and in the C_{18} series the triene acid present is linolenic acid, the main fatty constituent of pasture. Branched-chain fatty acids also occur in butter-fat. From April 1, 1951, the Geophysical Observatory, Wellington, has been renamed the Oceanographic Observatory, and studies of marine conditions in New Zealand waters have commenced. The Plant Chemistry Laboratory has continued its work on the synthesis of leaf protein from nitrate and ammonia derived from the soil with a further microbiological and chromatographic study of the amino-acids in leaf sap. The Seismological Observatory reports that seismic activity during 1950 was most intense during the first three months, the severest earthquake of the year occurring on March 1, 1951, in the region between Taupo and Waikaremoana. The Wheat Research Institute studied the sugar needs of fermenting doughs and found that these are much higher for long dough processes than for short ones. The Cawthron Institute completed its survey of hop soils, continued its studies of the role of trace-elements in Nelson crops, and again surveyed hop-gardens for the presence of black root-rot.

The Pottery and Ceramics Research Association was expanded to include the heavy clay products industry. Trials at the Dairy Research Institute showed that addition of 0·005 per cent of the anti-

* New Zealand. Twenty-fifth Annual Report of the Department of Scientific and Industrial Research. Pp. 80. (Wellington: Government Printer, 1951.) 1*s.* 6*d.*

oxidant, *nor*dehydroguaiaretic acid, reduced the amount of oxidation in butter during eight months of storage, but without improving the grade of butter. Of twenty overseas strains of streptococci examined, none was suitable for use as a cheese-starter in New Zealand. The Woollen Mills' Research Association made comparative tests with six worsted oils and also found that 'Lissapol *N*' in scouring removed the mineral oils satisfactorily. It was also found that 0·01 per cent of copper was the maximum amount that could be tolerated on the wool in dyeing, and even this amount noticeably affected weak dyeings of sensitive dyes.

QUALITY CONTROL OF LINOLEUM

ON January 31 the Linoleum Research Council, which has only been in existence for not quite three years, held its second symposium at the Grosvenor Hotel, London. The subject on this occasion was "Quality Control" as applied to linoleum, and not only was the industry itself well represented by the gathering of its technical men but also a number of visitors from other related industries were present. The meeting was opened by Dr. K. Turner, chairman of the executive committee, who said that this meeting was a direct result of the first symposium, entitled "The Rheology of Unmatured Linoleum", which had been held in the same place two years ago and which had been sufficiently successful to merit making these meetings a regular affair. He then handed the meeting over to the superintendent of research, Dr. S. R. W. Martin.

Five papers were presented, and as preprints had been circulated well in advance it was possible to devote most of the time of the meeting to a discussion, which was extremely stimulating and constructive. The first paper, by Mr. F. T. Walker (Messrs. Michael Nairn and Co.), was entitled "Dimensional Changes of Linoleum with Varying Humidity", and outlined the effect of water absorption on the cubical expansion of linoleum at normal temperatures. It was shown that the expansion of the linoleum is directly related to the amount of water absorbed. The effect contributed by the various ingredients of linoleum has been measured, and the fibrous fillers—cork or woodflour—have been shown to be almost entirely responsible. Various physical and mechanical factors which can influence expansion due to moisture absorption were discussed, and the superficial anisotropy of the linoleum sheet resulting from calendering demonstrated.

"The Indentation Machine as an Indication of the End Part in the Process of Maturing Linoleum" was discussed by C. W. Falkner (Linoleum Manufacturing Co., Staines) as an introduction to the study of the whole subject of mechanical testing as an aid to accuracy in judging the process of maturing which forms the final stage in the manufacture of linoleum, and a comparison was made between the indentation test and chemical tests, and new tests in respect of quite new and novel instruments. A more precise description of results obtained by the use of such a new testing device was discussed by P. J. Humphris (Linoleum Manufacturing Co.) in a paper entitled "The Rigidity Modulus of Linoleum". A large-scale rigidity machine was described, and attempts have been made to correlate results obtained from this machine with maturing times. There are clear indications that the modulus of rigidity in the case of linoleum is a sensitive property of some structural significance.

An alternative method of assessing the maturing stage of a linoleum was described by Messrs. J. C. Lawson, T. McQuillen and G. D. Rack (Jas. Williamson and Son, Ltd.) in a paper entitled "Some Experiments on the Application of Resilience Testing to Linoleum". Various common methods of measuring resilience of similar materials were discussed, and it was shown that a bouncing-ball technique and also a wheel-rebound test have given valuable results which may be a guide to the correct end of a maturing process.

An interesting paper, which was possibly outside the narrow subject of the symposium but nevertheless of interest to all present, was given by Dr. F. C. Harper (Building Research Station) on "The Measurement of Slipperiness of Floor Finishes". This described methods which have been used by various investigators for measuring slipperiness and showed how the problem can be simplified if more information is available about the mechanics of walking.

The meeting was concluded with a general summing up by Mr. A. G. Ward (director, British Glue and Gelatine Research Association). Dr. Martin thanked the company and suggested that, by the organization of such meetings where members of the industry can meet together and exchange information of material benefit, the Linoleum Research Council is amply fulfilling one of its functions by acting as a scientific centre for the industry.

PRODUCTIVITY IN THE PACKET FOODS INDUSTRY

REPORT OF THE ANGLO-AMERICAN COUNCIL ON PRODUCTIVITY

THE findings and recommendations of the productivity team representing the British packet foods industry that visited the United States last year are of interest to a wider field than those specifically concerned with food and its packaging. The recently published report of the team* does not endeavour to tell the British food industry how it should run its business, nor does it suggest that everything done in the United States is necessarily better than in Great Britain, the general conclusion appearing to be that, if in Britain there were the same unlimited supplies of materials, there would indeed be little difference in efficiency of either the foodstuffs prepared or in the quality of the packaging. Indeed, in this latter respect it seems that many of the undoubtedly superior packages and packaging methods used in the United States result from the ready availability of materials as well as the greater development of self-service stores which have called for more attractive packs in order to tempt purchasers.

Many interesting facts are presented in the report. One learns that food and agriculture in the United States is a "25 per cent industry"—one-fourth of the American income is spent on food, and the industry employs one-fourth of American workers. In the

* Productivity Team Report: Packet Foods. Report of a Visit to the U.S.A. in 1951 of a Productivity Team representing the British Packet Foods Industry. Pp. xii+71+9 plates. (London and New York: Anglo-American Council on Productivity, 1951.) 4s. 6d.

matter of expenditure on plant and equipment the only higher figure for the year is that of the chemical industry. The report deals with the question of management control and office management, and records that a surprising amount of attention is given to these matters as opposed to mechanics. On the matter of supplies, it is said that as regards raw materials the American food manufacturer lives in "a supplies paradise" and specified raw materials can be easily obtained—a matter for envy to those in Britain who for ten years have had to accept what has been given them.

In the section on production methods and factory buildings, the team stresses again the relation between paper work and the actual technique of production and directs attention to some interesting facts about the hazards of dust explosions. There is an undoubted "machine-mindedness" among American manufacturers, and volumetric filling, for example, is common, as are electrically controlled net-weighing machines. Pest control plays an important part in safeguarding packet foods, and close attention is paid to control measures by space fumigation, spraying, heat sterilization and the addition of insect repellants to carton- and case-sealing adhesives. It is claimed that this latter method reduces the incidence of infestation by half at a very low cost, a statement that occasions some surprise as comparable work in Britain does not indicate that such insecticides function satisfactorily unless the insect actually makes contact with the material used. No claims are made in Britain for any residual effects of the substance used as a repellant, although it is available and used mainly for spraying in agricultural usage where direct contact with the insect is possible.

In smaller factories in the United States it is usual to find both control and research being carried on in the same set of laboratories; but in the larger firms these functions are separated, some trouble being taken to ensure that the research worker is not thereby cut off from contact with works procedure and difficulties. Packaging materials are also subjected to known specifications, and there is excellent co-operation between suppliers and users, progress being greatly facilitated by the wide variety of flexible packaging materials freely available in the United States. The report gives details of a number of the tests used for such determinations as those of moisture, starch and sugar, gel strength, etc. Large sums of money are spent on scientific activities, and the results are there for all to see. The team states that it is fair to say that the *quality* of British work in this field is at least the equal of American work; it is to be hoped that an increasing number of British food manufacturers will take advantage of this fact and encourage the application of scientific methods throughout the industry.

In the field of industrial relations, the team was impressed by the normal friendly relations between labour and management, and employees do not appear to dislike the idea of their employers making a profit. From the section on sales and distribution, British packet food makers and others can learn much regarding the value of advertising, packaging, distribution and market research. Similarly there is much relevant information on the questions of warehousing and transport, although conditions are different in the United States.

The conclusions and recommendations of the team state, first and foremost, that American firms have attained higher productivity. The firms pay great attention to this subject, so that American workers are required to put less physical effort into their jobs than the British—nothing is moved by hand where a machine can be made to do the work. There is a very positive attitude to work—American workers appear to have no objection to overtime, or to shift work. In the field of packaging the possibilities of foil, plastic film and other new materials used in the United States are known in Britain, but their application is restricted by prevailing economic conditions.

It is recommended that steps should be taken by all British firms to make some measurement of productivity as a basis upon which future results can be assessed. Mechanization should be introduced wherever possible, and the whole production line, not single units, studied.

British food manufacturers, says the team, should make certain that the knowledge gained through research is given practical application in the factory. This recommendation can be taken to heart by manufacturers other than of foodstuffs.

Stress is given to the necessity for attractiveness and individuality of packages, and the final recommendation is that an American team should visit Britain. The report contains a number of flow sheets relative to the food industry, and illustrations of various weighing, stacking and packaging machinery. It forms a valuable and informative document which should do much to help the British food industry to further progress.

James Lawrie

1851 EXHIBITION SCHOLARS

Last year, towards the end of the Festival of Britain, a "Record of the Science Research Scholars of the Royal Commission for the Exhibition of 1851"* was published which, as the title implies, contains a list up to 1950 of all who have held 1851 Exhibition scholarships. Not the least of the great success of the 1851 Exhibition was the fact that it made a handsome profit; and the memory of its principal organizer, the Prince Consort, to which on the scientific side must be coupled the name of Lord Playfair, is enhanced by the many worthy uses to which the money was put. One such project was the scholarship scheme, and, from the time of its somewhat tardy inception in 1891, the scheme has been an unqualified success, as the list of nearly eight hundred scholars in this publication amply bears out.

In a foreword, Sir Robert Robinson, chairman of the Commissioners' Science Scholarship Committee and himself once an 1851 Exhibition scholar, points out that seventy-five scholars have been elected to the Royal Society and six have won Nobel Prizes. Modestly, he does not mention the Nobel Laureates by name, for he himself is numbered among them, having gained the award for chemistry in 1947. The other Laureates are C. G. Barkla (physics, 1917), Sir James Chadwick (physics, 1935), P. A. M. Dirac (physics, 1933), Sir Norman Haworth (chemistry, 1937) and Lord Rutherford (chemistry, 1907); since the list was published another name may be added—E. T. S. Waltón (physics, 1951). The booklet starts with two indexes, one of scholars and the other of institutions which have made successful recommendations for awards. Then comes the main part of the

* Record of the Science Research Scholars of the Royal Commission for the Exhibition of 1851. Pp. 92. (The Commissioners, 1 Lowther Gardens, Exhibition Road, London, S.W.7, 1951.) 7s. 6d.

publication, namely, a list of scholars appointed during 1891–1922 and two lists of appointments since 1922 of overseas scholars and senior students respectively. These lists take up four-fifths of the space and cover brief biographical details of each scholar.

The final part contains the regulations for science research scholarships during 1891–1922, and, since 1922, those for overseas scholars and senior students. The overseas scholarships are worth £450 a year for two (occasionally three) years and are for post-graduate students less than twenty-six years old from the Dominions of the British Commonwealth, being chosen as follows: three from Canada, two from Australia and one each from South Africa, New Zealand, India, Pakistan and the Republic of Ireland. Senior studentships, of which four a year may be awarded, are worth £600 a year for two (or occasionally three) years and are open to any British subject less than thirty years of age. They are awarded to students of exceptional promise and proved capacity for original work, and a glance at the list of previous holders proves that it is rare for the Commissioners' choice not to be amply justified.

BRITAIN'S NATIONAL FORESTS

BEDGEBURY AND CANNOCK CHASE

THE Forestry Commission has recently published two booklets dealing respectively with the national pinetum and forest plots of Bedgebury, Kent, and the State forest at Cannock Chase, Staffs*.

For many years the officials of the Royal Botanic Gardens, Kew, had been alarmed by the increasing debility of many of the conifer trees in the Gardens, due to increasing unsatisfactory conditions of soil and atmospheric impurities. In 1922 Sir John Stirling Maxwell, a forestry commissioner, suggested to Sir Arthur Hill, then director of Kew Gardens, that it might be possible for the Forestry Commission and Kew jointly to undertake the formation of a new pinetum on Forestry Commission land; and Lord Lovat, chairman of the Forestry Commission, approved. Several sites were examined, and Bedgebury was selected. Bedgebury forest occupies 2,431 acres of undulating land in the High Weald of Kent, close to the Sussex border and within a few miles of the small towns of Goudhurst, Cranbrook, Hawkhurst and Tenterden. It is probable that this area has been under woodland, like so much of the Weald, for many centuries. The name "Frith Wood", still applied to the main block of the forest, is possibly of Celtic origin. The Manor of Bedgebury, of which the forest was formerly a part, is a very old one, being first mentioned in a deed of Kenwulf, King of Mercia, in A.D. 815.

In Tudor and Stuart times the estate was in private ownership. At that period the forest, as in other parts of both the Kentish and Sussex Wealds, was an important centre for the smelting of iron with charcoal. The sites of the old 'hammer ponds' which provided the water power for the ironworker's hammer are still visible. The trade ceased only in the nineteenth century. Hornbeam coppices also give evidence of the brick-making which formed an industry, and chestnut coppices maintained for hop poles grown on a rotation of sixteen years. In either case oak standards were maintained over the coppices, though heavy fellings have taken place in the standards during and since the Second World War. A certain number of conifers were planted in the nineteenth century on the higher and less-fertile ground.

Eventually the Bedgebury woodlands were acquired by the Office of Woods and Forests, which transferred them in 1924 to the Forestry Commission. The woods at this time were of varying types. Oak, ash and birch were the main hardwoods occurring as standards, with sweet chestnut, hornbeam, hazel and some oak and ash as coppice. Scots pine was the chief conifer; but silver fir, Norway spruce, European larch and Douglas fir were present in belts and ornamental groups. Some damage was caused to the later plantings by a bad fire in 1942 and the difficulties of management during the Second World War. In round figures, the forest was made up in 1948 of 600 acres of plantations and 500 acres of chestnut coppice, 900 acres of Forestry Commission plantations and 150 acres of cleared land and scrub awaiting replanting. The pinetum occupies 64 acres and the forest plots 40 acres. There are three forest nurseries for raising forest trees.

In the Forestry Commission publication, which incidentally contains maps and some beautiful photographs, the national pinetum at Bedgebury is fully described by W. Dallimore, its real founder, and the forest plots are also considered. The more conspicuous genera in the pinetum are the larches, cedars, spruces, silver firs, Douglas firs, cypresses, pines, yews and other conifers.

Turning now to the subject of the other publication, Cannock Chase has a long, ancient and very interesting history; but the forest standing on the area to-day is a modern creation. Most of the land was acquired by the Forestry Commission between 1920 and 1929, and a steady annual planting programme was carried out until by 1935 nearly all the area was afforested. In 1950 most of the plantations varied in age from 14 to 30 years and from 10 ft. to 40 ft. in height. The plantations present a remarkably even appearance as they stretch along the fine straight roads that intersect the high and breezy uplands of the Chase.

The State Forest of Cannock Chase is situated in the centre of Staffordshire, between the county town of Stafford, the ancient ecclesiastical centre of Lichfield, and the busy industrial district around Cannock, Walsall and Wolverhampton. It occupies 6,000 acres of the distinctive Cannock Chase country, a region of high open moorlands, with a gravelly soil and a heathery vegetation, strongly contrasting with the fertile agricultural land to the east, north and west, and the mining and manufacturing towns that border it closely on the south. The plantations established by the Forestry Commission since 1921 on the then unproductive lands are chiefly of pines. From these the first yield of poles and pit props, from the thinnings of the older woods, are becoming available in steadily growing amounts for the use of agriculture, mining and industry in the neighbourhood. Already the young trees, which in the areas first planted are 40 ft. in height, are beginning to show the characteristics of a mature forest. Soon they may restore to the Chase some at least of the sylvan scenery which it possessed in Norman and medieval times.

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* Forestry Commission. Guide to the National Pinetum and Forest Plots at Bedgebury. Pp. iv+66+8 plates. 2s. 6d. net. Britain's Forests: Cannock Chase. Pp. 16. 9d. net. (London: H.M. Stationery Office, 1951, 1950.)

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Deuteron Reactions with Separated Magnesium Isotopes

Different investigators have studied the proton groups emitted during bombardment of magnesium[1]. Using separated isotopes and a counting method, Allan, Wilkinson, Burcham and Curling[2] have found three different groups from the reaction $^{24}Mg(d,p)\,^{25}Mg$ and one group from $^{26}Mg(d,p)\,^{27}Mg$. By bombarding magnesium-25, they found again three groups, the ranges and relative intensities of which, however, were nearly the same as those found in magnesium-24. They concluded, therefore, that the former groups were due to contamination with magnesium-24 and supposed that magnesium-25 under bombardment with deuterons (of 0·9 MeV.) does not emit protons at 90°. On the other hand, Pollard and Humphreys[3] earlier had reported the emission of three proton groups, although they did not state the actual energy release.

We therefore decided to study these (d,p)-reactions by means of photographic emulsions. Isotopic samples of magnesium of 15–90 μgm./sq. cm. were bombarded with deuterons of 1·9 MeV. The protons emitted at an angle of 90° were detected in a photographic emulsion (Ilford C 2, 100 μ) in an arrangement described earlier[4].

The following results, which are summarized in the table, were obtained:

Process	Range (μ)	Energy* (MeV.)	Q-value (MeV.)	Level (MeV.)	Relative intensity (approx.)
$^{24}Mg(d,p)\,^{25}Mg$	140	6·48	4·99±0·10	ground	20
	104	5·92	4·41±0·10	0·58	20
	81	5·58	4·05±0·10	0·94	15
	41	4·92	3·37±0·2	1·62	10
$^{25}Mg(d,p)\,^{26}Mg$	446	10·22	8·86±0·10	ground	1
	291	8·45	7·02±0·10	1·84	4
	203	7·34	5·86±0·10	3·00	7
	134	6·37	4·86±0·10	4·00	10
	108	5·98	4·45±0·10	4·41	15
	76	5·50	3·95±0·10	4·91	10
$^{26}Mg(d,p)\,^{27}Mg$	89	5·71	4·16±0·10	ground	35
	31	4·76	3·18±0·2	0·98	15

* Corrected for stopping in a mica foil.

$^{24}Mg(d,p)\,^{25}Mg$. Four proton groups were found. The first three groups give a Q-value and two levels in good agreement with other investigations[2,5]; the fourth group, however, has not been reported before. All four groups indicate the same excited states of magnesium-25 as found recently[6] in the process $^{27}Al(d,\alpha)\,^{25}Mg$.

$^{25}Mg(d,p)\,^{26}Mg$. Six proton groups were found. The three groups of longest range determine the ground-state and two excited states in magnesium-26 at 1·84 and 3·00 MeV., in close agreement with the levels given by Pollard and Humphreys (*loc. cit.*). It may be mentioned that these authors assumed that the process $^{23}Na(\alpha,p)$ gave quite different levels in magnesium-26. Recently, however, Motz[7] finds for the latter process levels at 1·91 and 2·85 MeV., and it seems reasonable to believe that these are the same states as occur in the (d,p)-reaction. (Motz also reports a level at 0·44 MeV.; in our work the corresponding proton group would coincide with a group due to nitrogen impurity in the targets, and we can therefore only conclude that, if such a group exists, it has a lower intensity than the group of longest range.)

The three shorter groups are those seen by Allan *et al.* A comparison with our groups from magnesium-24 shows that the ranges in the two cases differ by far more than the experimental error of the range measurements. For other reasons also we can exclude the possibility of contamination with magnesium-24, and we conclude that the groups in question are genuine, giving three more levels in magnesium-26.

$^{26}Mg(d,p)\,^{27}Mg$. Besides the strong group already reported by Allan *et al.*, we find indications of a weak group at 0·98-MeV. excitation.

A more detailed report of this work will be published in *Kgl. Dan. Vid. Selsk. mat.-fys. Medd.* I wish to thank Prof. N. Bohr for his continued interest, and Dr. S. Thulin, Nobel Institute, Stockholm, for preparing the isotopic samples. Mr. P. Oelgaard and Dr. S. Y. Tiwari have given me valuable assistance, especially in reading the plates.

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Use of Nuclear Plates for the Determination of the Uranium and Thorium Contents of Radioactive Ores

Mr. D. H. Pierson[1] has recently described a very ingenious method of determining the thorium–uranium ratio in radioactive ores. The main objection to his method is that it requires rather elaborate electronic equipment, and certainly could not be used in the field. In this respect the nuclear plate method presents great attractions, since the only essentials are some form of dark room and a fairly good microscope provided with a good micrometer eyepiece. A thick layer of the ore can be used, so that the ore need only be moderately finely powdered in a mortar and screened through a suitable mesh before the plate is placed in contact with it. We have found that an exposure time of eight minutes is suitable for thorium oxide, when in radioactive equilibrium. This exposure gives about twenty tracks in the field of a microscope using a 4-mm. dry objective and a × 10 eyepiece. Thus, even for comparatively poor ores, the exposure required would not be unduly long.

The results obtained by measuring the alpha-ray emission rate of the ore will, of course, be approximate, as Pierson points out. The stopping power of the ore for alpha-rays can be calculated from

Bragg's law only if exact chemical composition is known. Furthermore, if the radioactive material is not fairly uniformly distributed throughout the source, the theoretical formulæ used will be incorrect. It must also be assumed that the ore is in radioactive equilibrium. The actual quantity that is important in calculating the rate of emission of alpha-rays from a thick source is the density of the source divided by its stopping power. This quantity varies among the ordinary rock-forming minerals from about $1{\cdot}5 \times 10^{-3}$ for quartz to about $2{\cdot}1 \times 10^{-3}$ for magnetite. The values for heavy-metal compounds are higher; for example, $3{\cdot}9 \times 10^{-3}$ for galena and $3{\cdot}7 \times 10^{-3}$ for thorium oxide. Thus, if the ore to be examined was not too rich in the heavier metals, and we assumed a value of, say, $1{\cdot}8 \times 10^{-3}$, it seems unlikely that this figure would be incorrect by more than about 15 per cent.

It is clear that the rate of emission of the source is not sufficient to enable us to determine its thorium and uranium contents, and that a second relation is required. Mme. Joliot-Curie[3] has proposed to obtain this relation by calculating the thorium–uranium ratio from the ratio of the number of tracks in the emulsion whose range exceeded that of radium C′ to the number of tracks whose range lay between that of radium C′ and thorium A. The measurement of the range of the alpha-particle in the emulsion is difficult, since both the horizontal length and the vertical dip of the track must be determined. The dip can only be measured with the vertical slow motion of the microscope, and it is necessary to use an oil-immersion objective. The value obtained must be corrected for the difference of the indices of refraction of the oil and the emulsion, and also for the shrinkage of the emulsion during processing. The latter correction is uncertain, since J. M. McAlister and D. W. Keam[3] have shown that not only does the shrinkage factor for a single plate vary appreciably with the hygrometric state, but also that it may vary very much more between plates from different batches.

It seems, therefore, worth considering whether it would be possible to calculate the thorium–uranium ratio by measuring the horizontal lengths of the tracks only. This problem can be easily solved for a thin source, but we have been able to solve it for a thick source by only approximate partially graphical methods. We find that the thorium–uranium ratio is equal to

$$3{\cdot}6/(n_1/n_2 - 2{\cdot}15),$$

where n_1 is number of tracks with horizontal length exceeding the maximum range of radium C′; and n_2 is number of tracks with horizontal length lying between the maximum ranges of radium C′ and thorium A.

A full discussion of these results will be published shortly in the *Scientific Proceedings of the Royal Dublin Society*.

It is unlikely that any very accurate figures can be obtained by the photographic method. The value for the thorium–uranium ratio is not affected by the uncertainty of the value of the stopping power of the source, but unless the radioactive material is distributed uniformly throughout the source this value will be incorrect. We have found that powdered rock sources do not always fulfil the above condition, a fact that P. M. Hurley[4] has previously noted. Still, for rather rough and comparatively rapid radioactive assays, for which only fairly simple and portable apparatus is required, the method may have its uses.

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Geomagnetic Field Variations at Kodaikanal

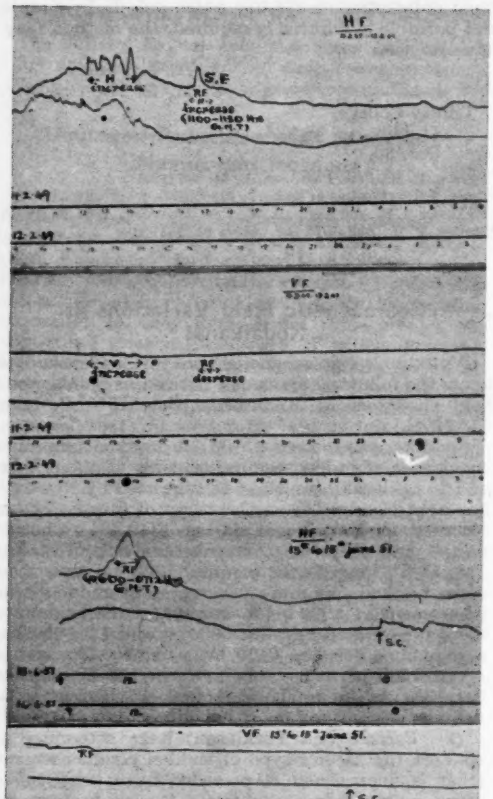
Workers in geomagnetism may be interested to know the following anomalies noticed in geomagnetic field variations at Kodaikanal (lat. 10° 14′, long. 77° 28′ E.) during 1949–51.

Sudden commencements. (1) A marked minimum occurrence of sudden commencements at about 8 hr. and 20 hr. local mean time, as suggested by Newton[1], has been observed from the study of fifty-two cases recorded at Kodaikanal during 1949–51. Chakrabarty[2] has observed from his analysis of Alibag (lat. 18·6°, long. 72·9°) records (1905–44) that there is no marked minimum occurrence of sudden commencement at 8 hr. local time, but the maximum is more pronounced between 0900 hr. and 1300 hr. and a minimum between 0400 hr. and 0700 hr. and at about 1700 hr. Possibly more of the Kodaikanal data should be analysed before we can come to definite conclusions on this point.

(2) Ferraro and Parkinson[3] have attempted to connect the second type of sudden commencements (that is, increase in H preceded by a small movement in the opposite direction) with geomagnetic longitude. This second type of sudden commencement is absent from Kodaikanal (geo. mag. long. 148·2°) magnetograms during 1949–51. This is not in agreement with the suggestion made by Ferraro and Parkinson. In this, Kodaikanal resembles stations like Alibag and Honolulu. In this connexion, it may be mentioned that sudden commencements of the second type as recorded at Huancayo[4] on January 24, March 9, March 16 and October 13, 1949, have appeared in Kodaikanal and Alibag magnetograms as sudden commencements of the first type.

(3) Some of the sudden commencements recorded at Kodaikanal have not been recorded at other observatories. For example, on November 19, 1949, a distinct sudden commencement was recorded at Kodaikanal at 0604 hr. G.M.T., but Alibag does not report any sudden commencement on that day. On December 14, 1949, a sudden commencement was reported by Huancayo[4] at 0342 hr. G.M.T.; but none was observed on that day either at Kodaikanal or at Alibag. On July 16, 1949, at 1224 hr. G.M.T., an inverted sudden commencement was recorded both at Kodaikanal and at Alibag, but Huancayo does not report any on that day. The above cases are only a few of the types, and more data have to be analysed at Kodaikanal before we can ascertain how far observations of the same sudden commencement made at different places fail to be simultaneous.

(4) During sudden commencements, the Kodaikanal magnetograms show a simultaneous increase in both H and V, as was pointed out earlier by A. K. Das and Raja Rao[5] for the great storm of January



Typical geomagnetic crochets recorded at Kodaikanal on February 11, 1949, between 1100 hr. and 1130 hr. G.M.T. and on June 13, 1951, between 0600 and 0712 hr. G.M.T. showing increase in H and decrease in V on February 11, 1949, and increase in H and V on June 13, 1951, synchronous with intense flares (S.F.) and radio fade-outs (R.F.)

24–26, 1949. During storm time variation, in certain cases, a decrease in D (westerly) synchronous with the increase in H and V has been noticed, which is rather unusual for this latitude.

Geomagnetic effects during solar flares. McIntosh[6] has, in a recent communication in *Nature*, pointed out that there are substantial differences between the space distribution of the ionospheric currents producing geomagnetic effects of solar flares and those producing the normal daily magnetic variations from his study of the geomagnetic solar flare effects and normal magnetic daily variation at Lerwick, Eskdalemuir (Scotland) and Abinger. At Kodaikanal, a study of the geomagnetic crochets that have occurred during 1949–51 shows that ΔH when present is invariably positive, and ΔV when present is generally negative. But on June 13, 1951, a remarkable geomagnetic crochet of unusual duration between 0600 hr. and 0712 hr. G.M.T. was recorded synchronously with an intense radio fade-out observed by the All-India Radio. The signs of H and V in the crochet are found to be the same, which is rather unusual for this latitude. However, on February 11, 1949, the signs of H and V in the geomagnetic crochets recorded at Kodaikanal (see records reproduced) synchronously with an intense flare observed at Edinburgh between 1100 hr. and 1130 hr. G.M.T. are found to be opposite. It may be noted that just before the crochet between 0630 hr. and 0830 hr. there are four distinct rises in the H trace with corresponding rises in the V trace, clearly indicating that the mechanisms for the two cases on February 11, 1949, that is, storm time variation (0630 hr. and 0830 hr. G.M.T.) and flare effect variation (1100 hr. and 1130 hr. G.M.T.), are entirely different.

Again, in certain cases of normal daily magnetic variation at Kodaikanal, the sense of V is found to be the same as that of H, which is quite contrary to the usual normal variations for this latitude.

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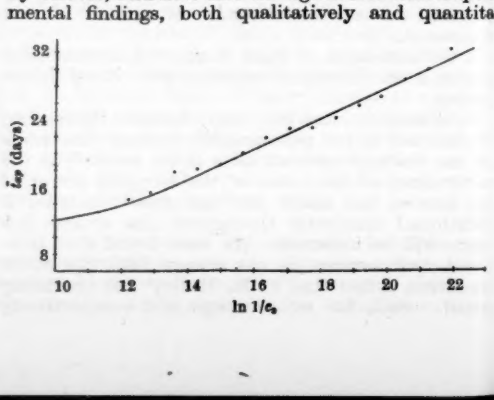
Application of the Quantum Hit Theory to Virus-provoked Tumours

In two previous papers[1,2], the quantum theoretical hit theory, which has been applied so successfully, for example, to gene mutations, has been applied to the problem of spontaneous cancer and cancer induced by carcinogenic hydrocarbons. The fundamental assumption of the hit hypothesis is that most, if not all, biological processes are ultimately governed by certain control centres, which are situated in the cell nuclei and are thought of as giant molecules making quantum jumps when acted upon by different agents such as chemical substances, viruses, neutrons, X-rays and other ionizing radiations. In the case of mutations, these centres are now generally believed to be genes. Analogously, we have assumed in the papers referred to above that there is in each cell a certain control centre, perhaps of an enzyme-like nature, which controls the velocity of the chemical chain reactions which in turn control the velocity of growth and thus the rate of proliferation of the cells.

We have now applied our theory to cancer produced by viruses, and here also the agreement with experimental findings, both qualitatively and quantita-



tively, has been very satisfactory. In the accompanying graph, we show the experimental points of Bryan and Beard[3] giving the average induction time (in days) of papillomas induced in rabbits versus $\ln 1/c_0$, where c_0 is the applied concentration (in grams) of the carcinogenic papilloma virus from extracts of cottontail rabbit warts, together with the theoretical curve deduced from our theory and fitted to the experimental points quoted. The fact that this logarithmic dependence of induction time on concentration may be deduced unambiguously from the assumptions of our theory strongly supports the feasibility of applying the quantum hit theory to the problem of cancer production.

A detailed account of this theory applied to virus-induced cancer will shortly be published in *Acta Path. Microbiol. Scand.*

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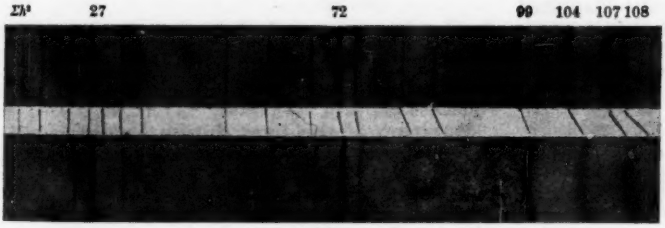
A New Complex Eta-Carbide

THE crystal structures of many carbides occurring in alloy steels have now been elucidated. One of their most striking characteristics is that they exist over quite extensive ranges of composition by permitting a high degree of atomic substitution to occur. A typical example is the η-carbide of high-speed steel, which extends over the range Fe_4W_2C to Fe_3W_3C. Structurally similar carbides have been shown by V. Adelsköld, A. Sunderlin and A. Westgren[1] to occur in the systems cobalt–tungsten–carbon, nickel–tungsten–carbon and iron–molybdenum–carbon. The stability of these η-carbides seemed to decrease in the order Fe_3W_3C, Co_3W_3C and Ni_3W_3C, and it was concluded that the reason for the non-occurrence of this type of carbide in the systems cobalt – molybdenum – carbon and nickel – molybdenum–carbon was due to their low stability, which caused them to decompose in cooling from the melt. In the chromium–tungsten–carbon alloys a quite different cubic carbide phase was found having the same structure as the cubic carbide $Cr_{23}C_6$.



Debye-Scherrer patterns of (above) η-carbide (Fe_4W_2C) from high-speed steel and (below) extract from an iron-free nickel-base alloy. Manganese $K\alpha$ radiation, 9-cm. diameter camera

The structure of the double carbide Fe_3W_3C has been shown by Westgren[2] to be of cubic symmetry, having the space group F_{d3m}, and lattice parameter 11·08 kX. The number of atoms per unit cell is 112, of which 96 are metal atoms and 16 carbon. The unit-cell dimensions of the η-carbides are quite close to each other, being 11·08 kX. for Fe_3W_3C; 11·09–11·12 kX. for Fe_3Mo_3C; 11·01 kX. for Co_3W_3C; and 11·15 kX. for Ni_3W_3C.

During a recent examination of a complex iron-free nickel-base alloy containing cobalt, chromium, molybdenum and tungsten, a micro-constituent, thought to be a carbide, was extracted by electrolysing a ¼-in. diameter bar of the alloy in a solution of commercial methylated spirits containing 5 per cent hydrochloric acid for 260 hr. at an initial current density of 0·011 amp./cm.². The Debye–Scherrer pattern of the extract shown in the accompanying figure was closely analogous to that of a sample of η-carbide (Fe_4W_2C) kindly supplied to us by Mr. H. J. Goldschmidt; but its lattice parameter was very much lower, namely, 10·951 kX. against 11·0246 kX. for the reference sample, and 11·08 kX. given by Westgren for Fe_3W_3C.

Chemical analysis of this new η-carbide revealed, in addition to nickel and carbon, the presence of appreciable amounts of silicon, chromium, cobalt, tungsten, molybdenum and nitrogen. By grouping these elements in accordance with their positions in the Periodic Table and assuming that silicon atoms occupy positions normally occupied by a transition element, the structural formula of the new carbide becomes

$$(Ni_{0\cdot58}Co_{0\cdot30}Si_{0\cdot12})_3(Mo_{0\cdot49}W_{0\cdot07}Cr_{0\cdot44})_3(C_{0\cdot95}N_{0\cdot05}),$$

which is analogous to the complex high-speed steel η-carbide $Fe_3(W,Mo)_3C$ reported by Goldschmidt[3] in his review of the structure of carbides in alloying steels.

So far as we are aware, this is the first occasion on which an iron-free chromium-rich η-carbide has been reported. Basically it is the complex double-carbide $(Ni,Co)_3Mo_3C$ which Westgren *et al.*[1] were unable to synthesize. Presumably the structure is stabilized by the presence of chromium and silicon. These atoms are appreciably smaller than the atoms of tungsten, molybdenum and iron, which they replace in the structure, thus causing the lattice parameter to fall substantially below the normal value. It would also be anticipated that this new η-carbide would extend over a wide range of composition without change in the pattern of atomic sites in the same way as the cubic chromium carbide varies from $Cr_{23}C_6$ to $(Cr,Fe,W)_{23}C_6$.

We wish to express our appreciation to the Mond Nickel Co., Ltd., for permission to publish this communication.

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A Sensitive Method for the Detection of Traces of Water in Oil

Where electrical components are immersed in oil as in transformers or servo systems, dissolved water even in traces may have an adverse effect on insulation material, especially if air (to supply oxygen) and a metal (such as copper, to act as a catalyst) are present as well. It therefore becomes important to know if water is present and, if so, how much.

What is apparently a new and sensitive method of measuring the water content of oil has been discovered in this laboratory. The method relies on the fact that perfectly dry air, arranged to stand over a 'wet' oil, will take up moisture from the oil until the partial relative humidity of the air (at the prevailing room temperature) is the same as the volume concentration of the water in the oil.

A 'humidiscope' has been devised to determine this partial humidity. It consists of a metal tube 4 in. long by 1 in. bore arranged to stand vertically; the bore is divided into an upper chamber of approximately 40 ml. capacity and a smaller, lower one by a pipe-clay diaphragm; the top chamber contains a wire-mesh 'chip-basket' holding a powerful desiccant such as 1/8 in. cubes of freshly dried porous calcium chloride; a glass plate is waxed on to the top of the tube to effect closure. The lower, smaller chamber has the air in it also brought to zero relative humidity by standing over a 'drying pit' (containing the same desiccant) in a metal base; an oil manometer connected to the two chambers gives a zero reading when both are at zero relative humidity. A thin mica strip is then slid under the instrument, which is slid bodily sideways to cover a second 'pit', filled to the brim with the oil sample; this procedure prevents any atmospheric air (and its associated moisture) from getting into the lower chamber. Moisture then diffuses from the oil surface into the dry air in the lower chamber and the relative humidity established causes a differential pressure head across the porous diaphragm which is indicated by the manometer.

It has been shown[1] that the vapour pressure p in mm. mercury is

$$p = \rho \sqrt{\frac{RT}{2\pi m}},$$

where R is the gas constant ($1{\cdot}372 \times 10^{-16}$), T is absolute temperature (° C.), ρ is gm./ml. vapour in air, m is mass of a water molecule.

If the saturated vapour pressure of water at the temperature of the experiment is p_{sat} mm. mercury, then $p_{sat} \propto 100$ (relative humidity). Further, from Graham's law,

$$\frac{v_1}{v_2} = \frac{\sqrt{\rho_2}}{\sqrt{\rho_1}},$$

where v is the rate of diffusion through a porous membrane.

From this,

$$\frac{p_1^2}{p_2^2} = \frac{\rho_2}{\rho_1},$$

where p is the vapour pressure associated with the vapour density ρ.

Hence the relative humidity of the air above the wet oil may be expressed as

$$RH = \frac{p^2}{\left(p_{sat} \times 13{\cdot}6 \times \frac{1}{0{\cdot}871}\right)^2},$$

where 0·871 is the specific gravity of the oil used in the manometer; p_{sat} is obtained from tables of water vapour pressure.

Tests are still in progress, but some results which have been obtained are given in the accompanying table.

Test No.	Oil	Wetness by humidiscope (%)	Wetness by carbide test (%)
1	*OM*.13, a very light mineral oil	0·081	(*a*) 0·09 (*b*) 0·12
2	*OM*.35, a light mineral oil as used for servo mechanisms	(*a*) 0·28 (*b*) 0·276	0·19
3	Castor oil. (BP quality)	(*a*) 1·13 (*b*) 1·20	(*a*) 1·25 (*b*) 1·36
4	Olive oil (BP quality)	(*a*) 0·26 (*b*) 0·33	—

These four oils were clear and 'bright' and it came as a surprise that they contained so much dissolved water.

In general, it has been found that the carbide test may not always be reliable for mineral oils as these often contain addition agents; certain mineral oils give results that are much too high, and it is thought this may be due to side-reactions involving the addition agents.

It is intended to publish a fuller account of this work later when it has been completed.

I am indebted to the manager of this laboratory, Lieut.-Cdr. J. R. D. Walker, for permission to make this communication.

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Rotation of the Eyes during Involuntary Blinking

It is apparent from a review in *Nature* by Lawson[1] that there are few published data on movements of the eyes during blinking. In the course of a more general investigation on eye movements[2], I have recently obtained several records of rotations of the eye during blinking. The records are made by photography of a beam of light reflected from a small flat worked on a contact lens.

Evidence has been obtained that the lens follows the eye movements precisely and does not affect their velocity. On most occasions the lids remain sufficiently far apart during the blink to leave the flat at least partly unobscured. The horizontal and vertical components of the rotations of the eyes during the blink may therefore be deduced from the records. These show that the eye moves simultaneously inwards and upwards through angles of about 20–100 min. of arc inwards (15 blinks, two subjects) and 40–70 min. of arc upwards (5 blinks, two subjects): the movement occupies 0·04–0·09 sec. The times for the two eyes are identical; but the magnitude of the angular movements may be widely different. The return movement to the original

direction of fixation is slower, taking 0·07–0·15 sec., and usually occurs in more than one stage, the eye slowing up, stopping and even reversing its direction for one to three periods of 0·01–0·02 sec. during the course of the return. The complete movement occupies 0·11–0·24 sec.; the movements of the eye after this period form part of the pattern of normal involuntary eye movements during fixation.

It is not possible to relate the times of closure of the lids and movements of the eyes, since records of lid movements were not made; but the duration of the inward and upward movement corresponds fairly closely to the time taken for the lids to close[1] (0·04–0·05 sec.). It is therefore reasonable to suppose that this movement is synchronous with lid closure. The total period of eye movement (0·11–0·24 sec.) is rather less than the usually accepted total time from the beginning to the end of movements of the lids (0·3–0·4 sec.). If this is so, the eye returns to its normal direction of fixation before the movements of the lids have ceased, and any disturbance to vision after the completion of the lid movements is not due to an incorrect direction of fixation.

The results support Lawson's claim[1] that the value of 10°–15° given by Miles[3] for the upward movement of the eye during blinking is considerably too high.

I am indebted to Prof. R. W. Ditchburn for advice and encouragement, and to the Department of Scientific and Industrial Research for a maintenance grant.

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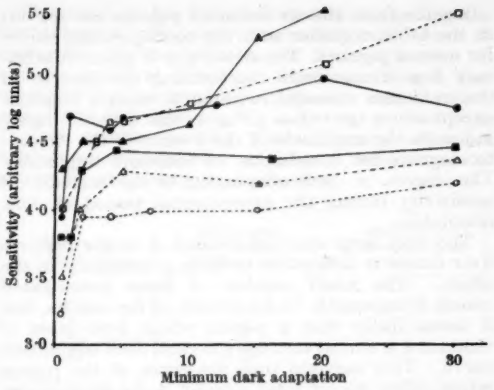
Effect of Vitamin A-Deficiency on the Dark Adaptation of the Pigeon

Granit[1] has stressed the uniformity of the Purkinje shift in various kinds of eye, and concludes that there must be a chemical correlation between the rod and cone substances. Since vitamin A-deficiency is known to reduce the amount of visual purple in the retinal rods and to diminish the ability of the animal to become dark-adapted, it is of interest to see what effect vitamin A-deficiency has on the retinal function of an animal the retina of which is made up almost wholly of cones. I have measured the dark adaptation of normal and vitamin A-deficient pigeons by determining the height of the *b*-wave of the electroretinogram using a light of constant brightness, and also by measuring the minimum intensity of light required to elicit an electrical response from the eye. Similar experiments on animals the retinæ of which are made up almost wholly of rods[2,3] have shown the sensitivity of the retina to be greatly reduced during deficiency and to be restored to normal on giving vitamin A concentrate.



Two groups of three pigeons were fed a diet of oats and bran[4] (rabbits kept on this diet develop signs of deficiency in two–six months, according to their age[3,4]). The first three pigeons were all adult when the experiment was started, and at no time showed any clinical sign of deficiency. Two died under the anæsthetic used for obtaining the electroretinogram recording after two and seven months respectively, but the third was kept on the deficient diet for two years. The second group of three pigeons was started on the deficient diet when the birds were two to three weeks old. Growth was normal at first, but the pigeons began to lose weight and to show dryness and scaliness of the face after seventeen to eighteen months. The only change in the eye that could be seen by slit-lamp examination was the formation of a 'scum' on the cornea. Two birds died after eighteen months deficiency, and the third was then given 100 I.U. vitamin A/gm. of food. Normal weight was regained in a few weeks and the scaliness of the skin disappeared, but the general appearance did not become quite normal until a mixed diet was given. Dark adaptation in this bird remained substantially normal throughout the eighteen months deficiency, during vitamin A supplementation and after returning to a normal mixed diet. Curves from this pigeon (No. 6) are compared with curves from three normal pigeons in the accompanying graph.

Pigeon No.	Age at start	Months deficient	Dark adaptation curve	Maximum sensitivity	Degree of dark adaptation	Vit. A in liver (ref. 5) (I.U./gm.)	Remarks
N	adult	—	—	104–136 μV.	96–125 μV.	1,540	Normal by definition
N	adult	—	—	4·0–5·5	1·1–1·5	1,230	" " "
N	3 wk.	—	—	—	—	1,006	" " "
1	adult	2	normal	104–230 μV.	88–190 μV.	—	Died under anæsthetic
2	adult	7	normal	88–130 μV.	37–130 μV.	—	" " "
3	adult	24	normal	4·0–5·5	1·0–1·5	81·5	Killed " "
4	3 wk.	18	normal	—	—	0	Died before electroretinogram could be done
5	2 wk.	18	normal	4·0	1·2	49	Died after a single dose of 1,000 I.U. vitamin A given before electroretinogram recording
6	3 wk.	18	normal	5·0	1·2	—	—
"	"	"	?	5·5	1·2	—	After 100 I.U. vitamin A/gm. food for 4 months
"	"	"	normal	4·8	0·8	—	Normal mixed diet for further 5 months

Results from the six deficient pigeons are set out in the table, together with the corresponding values for normal pigeons. The sensitivity is given in arbitrary logarithmic units representing the inverse of the minimum stimulus required to elicit a response except where quoted as μV.; in this case the figure indicates the amplitude of the *b*-wave of the electroretinogram for a stimulus of constant brightness. The degree of dark adaptation is the increase of sensitivity during the experimental period of dark adaptation.

The very large store of vitamin A in the pigeon's liver makes it difficult to produce a deficiency in the adult. The small number of birds investigated makes it impossible to be certain of the results, but it seems likely that a pigeon whose liver store of vitamin A is almost zero has a normal dark adaptation curve. This suggests that the cones of the pigeon retina either do not need vitamin A for their proper function, or that the amount needed is very much less than that required for rod vision in the rabbit.

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Different Forms of *Rh* Antibodies

In recent years a number of reports have been published on the occurrence of *Rh* antibodies other than the saline agglutinins and the incomplete or blocking antibodies (the 'bivalent' or 'univalent' antibodies in Wiener's terminology). Wiener himself now subdivides the univalent antibodies into glutinins and blocking antibodies; both are detectable by the serum–albumin conglutination technique. Witebsky and Mohn have reported the finding of a second type of blocking antibody, which blocks glutinins but not agglutinins. In addition, these workers have confirmed the occurrence of still another type of antibody which was originally described by Hill and Haberman and was called the cryptagglutinoid. This has neither agglutinating nor blocking properties, but can be adsorbed on to *Rh*-positive cells and is detectable by the indirect Coombs technique. The five different *Rh* antibodies or phases of antibody activity and the tests by which the various workers claim they are detected are set out in Table 1.

Table 1. Tests for Detection of *Rh* Antibodies

Type of *Rh* antibody	Serum–albumin conglutination test	Indirect Coombs test	Saline agglutination	Wiener blocking test
Bivalent antibody				
Rh agglutinin	+	−	+	−
Univalent antibodies				
1. Glutinins	+	+	−	−
2. Blocking for agglutinins	+	+	−	+
3. Blocking for glutinins	+	+	−	?
4. Cryptagglutinoids	+*	+	−	−

* Not always detectable by this test.

These discoveries suggested to us an explanation for the widely varying results observed when *Rh* antibody titres are estimated by the different techniques. It has been generally accepted that these differences are due to variations in sensitivity of the testing methods. This explanation seemed unsatisfactory, and we have therefore submitted nine sera to detailed analyses by different techniques and have subjected our results to close scrutiny by statistical methods. The details of our experiments will be published elsewhere. Our conclusions may be summarized as follows.

First, the occurrence of all five varieties of antibodies, glutinins, blocking antibodies for glutinins and cryptagglutinoids in addition to the well-established saline agglutinins and blocking antibodies for saline agglutinins has been confirmed. Secondly, we suggest that if different titres of *Rh* antibodies are obtained in one and the same serum by the use of different techniques, this is not due to a variation in sensitivity of the techniques but to the fact that the serum contains a mixture of different forms of antibody. One method (for example, saline agglutination) will detect only one antibody type, whereas another (for example, the serum albumin conglutination test) will detect several of them, and in this way different results will be obtained.

Table 2, a modification of the previous summary, expresses our interpretation of the techniques at present available for detecting and distinguishing the different forms of *Rh* antibody.

Table 2. Tests for Detecting and Distinguishing *Rh* Antibodies

Form of antibody in serum under investigation	Serum–albumin conglutination test	Indirect Coombs test	Saline agglutination	Wiener blocking test
Bivalent antibody				
Rh agglutinin	+	−	+	−
Univalent antibodies				
1. Glutinins	+	−	−	−
2. Blocking for agglutinins	+	−	−	+
3. Blocking for glutinins	+	−	−	?
4. Cryptagglutinoids	−	+	−	−

Inspection of this modified table shows that some of the forms of antibody can be easily distinguished; for example, the saline agglutinins by their reaction in the saline agglutination test, and the cryptagglutinoids by their reaction in the indirect Coombs test. However, the others, the glutinins and both types of blocking antibodies, react primarily in the serum–albumin conglutination test. It is, however, possible to distinguish them by applying the following procedure.

The titre of *Rh* antibodies in a serum containing agglutinins (A.S.) or glutinins (G.S.) diluted with the serum under investigation (X.S.) is compared with the titre of antibodies in the serum (A.S. or G.S.) diluted to the same concentration with pooled homologous serum (P.S.). If a serum under investigation (X.S.) contains any saline agglutinins, these must first be destroyed by heat (56° C.) A mixture of one part A.S. or G.S. with two parts X.S. appeared to be the most satisfactory proportion and is therefore recommended for these tests.

The form of the antibody present in the serum under investigation can be decided from Table 3.

Table 3

1. Glutinins (if not blocked)	Saline titre of 1 A.S.+2 X.S.	equal to	Saline titre of 1 A.S.+2 P.S.
2. Blocking antibody for agglutinins	Saline titre of 1 A.S.+2 X.S.	significantly less than	Saline titre of 1 A.S.+2 P.S.
3. Blocking antibody for glutinins	Serum-albumin titre of 1 G.S.+2 X.S.	significantly less than	Serum-albumin titre of 1 G.S.+2 P.S.

What clinical implication these serological distinctions entail will become clear only after analysing the forms of antibody present in the blood of a large number of sensitized mothers in relation to the effect produced in their children. We hope to report such a correlation in another paper.

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Methionine Sulphoximine and some Enzyme Systems involving Glutamine

METHIONINE sulphoximine is toxic to a wide range of living organisms. Apart from the neurotoxic effect upon animals and the inhibition of the growth of certain bacteria, it also inhibits the germination of seedlings and the larval development of the insect *Tribolium confusum* (unpublished observations). In an earlier report[1] it was shown that the toxic effect upon *Leuconostoc mesenteroides* is reversed by *l*-glutamine, and it is useful to know whether in higher organisms methionine sulphoximine also interferes with enzyme processes involving glutamine. It appeared pertinent, as a first approach, to examine the effect of methionine sulphoximine on the enzyme systems concerned in the synthesis of glutamine[2,3] and the transfer of glutamyl groups[4–8], as these are widely distributed and are considered important in the primary stages of peptide bond formation[9,10]. In addition to this general aspect there is a more particular interest attached to the question of whether, in mammalian tissues, there may be a relationship between sulphoximine and glutamine. This arises from the work of Tower and K. A. C. Elliott[11], who have shown that on incubation of slices of cerebral cortex tissue, from animals convulsed with methionine sulphoximine, bound acetylcholine fails to increase, but that this anomalous effect is reversed if glutamine or methionine is added to the suspending medium.

Both the glutamine synthesizing enzyme[3] and a glutamyl transferase system[4] may be studied in extracts prepared from acetone powders of brain. Acetone powders of sheep brain have been used to observe the effect of methionine sulphoximine on these enzyme systems. Extracts prepared essentially as described by W. H. Elliott[3] have been used as a source of the glutamine-synthesizing enzyme, and the methods of Schou *et al.*[4] have been followed for the transferase system. It has been found, with such extracts, that methionine sulphoximine depresses the synthesis of glutamine from glutamate, but the inhibitory effect is relatively much more pronounced with the transferase system.

This reaction has been followed by measuring the formation of glutamyl hydroxamic acid from *l*-glutamine, in the presence of hydroxylamine, in acetate buffer at *p*H 5·5. Hydroxamic acid was measured by the method of Lipmann and Tuttle[12], using succinyl hydroxamic acid as a standard. Typical results showing the inhibitory effect of methionine sulphoximine at different initial levels of glutamine are shown in the table.

Micromoles *l*-glutamine	Micromoles *l*-methionine sulphoximine	Micromoles hydroxamic acid formed
60	nil	5·85
60	0·38	4·0
40	nil	4·15
40	0·38	2·7
30	nil	3·2
30	0·38	1·9

The system also contains, in 2 ml.: hydroxylamine, 40 micromoles; phosphate and manganous chloride, 10 micromoles; 0·05 *M* acetate *p*H 5·5; extract of acetone-dried sheep brain. Incubated for 50 min. at 37°.

The production of glutamyl hydroxamic acid has been confirmed from time to time by adding alcohol (up to 66 per cent by vol.) to the reaction mixture after 2 hr. at 37°, centrifuging off the precipitated protein, drying an aliquot of the supernatant liquid *in vacuo* at room temperature, dissolving the dried material in a little water and applying this solution to a filter-paper chromatogram. The glutamyl hydroxamic acid may be 'spotted' with both ninhydrin and ferric chloride solutions.

No production of hydroxamic acid has been observed when glutamine is replaced by glutamate or by water. If sulphoximine is present at the same molar concentration as glutamine, there is practically no formation of hydroxamic acid. Aliquots prepared from reaction mixtures containing such equimolar concentrations of glutamine and sulphoximine have been examined on paper chromatograms with the object of detecting whether a γ-glutamyl-sulphoximine is formed. Such compound formation has not been demonstrated, and, at present, it seems that the inhibitory effect is due to competition with glutamine rather than to compound formation. But kinetic data are required to establish this more conclusively. The inhibition is not measurably reversed by *l*-methionine at a methionine/sulphoximine ratio of 40 : 1. The transferase reaction may proceed by stages, and one step, reaction of hydroxylamine with a (hypothetical) glutamine intermediate compound—for example, glutamyl phosphate—may be non-enzymatic. If there is a non-enzymatic step, it is clearly desirable to establish that the effects of inhibitors are not due to blocking that stage. In the present example the only conclusive way of establishing this point would appear to be the substitution of hydroxylamine by ammonia, 'labelled' with a nitrogen isotope, as the glutamyl 'acceptor'. Facilities for this approach are not available to us, but the effects of *l*- and *dl*-methionine sulphoximine have been compared and only the *l*-form appears to be effective. This makes it more probable that an enzymatic stage is involved.

In addition to its known anti-methionine activity[13–15], methionine sulphoximine may thus also interfere with some processes in which there is interchange of glutamyl groups. Whether or not this is a factor in its neurotoxic activity requires further investigation. A problem of practical importance—the widely varying susceptibility of different animal

species towards agenized protein—also still remains. It is possible that this may be related to a difference between species in the ability to eliminate or detoxify methionine sulphoximine.

We are grateful to Mr. R. G. Westall for a gift of *l*-glutamine.

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An Effect of Adrenalectomy and Cortisone on Tissue Permeability *in vitro*

A few years ago a simple technique was described whereby the swelling of tissue slices in various solutions could be measured[1]. This swelling was presumably largely the result of osmotic activity and reflected the permeability of structures within the tissue slice to substances in the bathing solution. With brain cortex slices it was found that some swelling occurred in isotonic or hypertonic sodium chloride solutions lacking protein. In solutions containing only sugars, extreme swelling occurred as if the sugars penetrated membranes freely and exerted no osmotic pressure. But in the presence of small amounts of electrolytes the sugars behaved as completely non-penetrating. The effects of various materials, including an adrenal cortical extract, were tested to see whether they could influence the swelling or the effect of electrolyte. No obvious result was obtained at that time. Clearly significant effects of adrenalectomy and cortisone, but not of deoxycorticosterone, have now been obtained.

Details of the method for measuring the swelling were described previously[1]. Slices of standard thickness were prepared in a humid chamber, weighed, immersed in the oxygenated fluid at room temperature for 30 min. (usually), drained and re-weighed. The figures for swelling reported here are those actually obtained and have not been corrected for losses by control slices on brief immersion.

Hooded rats of a pure strain were used. Adrenalectomy was carried out 24–48 hr. before the experiment in one stage. Its completeness was verified at autopsy. Cortisone (free from alcohol) was kindly provided by Merck and Co., Ltd., and deoxycorticosterone (free from alcohol) by Dr. E. Lozinski, of Charles E. Frosst and Co., Montreal. For experiments with these substances, 3 mgm. was dissolved in 0·3 ml. alcohol and the solution was added to 30 ml. of the aqueous medium. For the simultaneous controls, alcohol without steroid was added to the medium.

Variability made it difficult to draw conclusions with brain slices immersed in normal saline, in which swelling is relatively small, or in isotonic glucose in which swelling is too extreme. Experiments on immersion in a mixture of 9 parts isotonic glucose and 1 part isotonic saline solution showed a considerably greater swelling with slices from adrenalectomized rats than from normal rats. The average figures were 30 and 17 per cent respectively, and the difference was statistically highly significant in spite of large variations from the mean (standard deviations 11 and 5).

With liver slices immersed in isotonic glucose solution, the relation between swelling and variability between replicates was such that significant observations could be made more readily (see table).

Swelling of Rat Liver Slices in Isotonic Glucose Solution with and without Cortisone or Deoxycorticosterone
Percentage increase in weight

Normal rats		Adrenalectomized rats		
—	Cortisone	—	Cortisone	Deoxycorticosterone
Sets of figures between parentheses were obtained from one liver				
(25, 10, 11	16, 12, 5)	(44, 40, 34	25, 23, 20)	
(33, 23, 19	33, 25, 17)	(40, 39, 39	25, 24, 17)	
		(46, 43, 34	25, 20, 10)	
		(51, 44, 43	18, 17, 14)	
		(38, 36, 32		47, 43, 36)
		(43, 30, 30		32, 32, 22)
Averages* ± standard error of the mean. Number of experiments in parentheses				
22±2 (12)	18±4 (6)	38±1 (24)	20±1 (12)	35±4 (6)

* Averages of above and other figures.

The average swelling of tissue from adrenalectomized animals was nearly twice as great as that of tissue from normal animals, and the presence of cortisone reversed this effect. The figures indicating these conclusions are highly significant. In the few experiments with cortisone on normal liver and with deoxycorticosterone on liver from adrenalectomized animals, no significant indications of effects were observed. A few comparisons of the swelling obtained in a medium consisting of 9 parts isotonic glucose and 1 part isotonic sodium chloride showed no obvious difference between livers from normal and adrenalectomized animals, the average figures being 19 ± 1 and 17 ± 1 respectively.

These results seem to indicate, as has been suggested by other aspects of the study of adrenal hormones, that certain of these hormones, including cortisone, are concerned in the regulation of the permeability of cell membranes or of some other tissue structures. In the present experiments the tissue has been subjected to an abnormal environment in which the osmotic pressure is almost normal but the permeability of tissue structures is abnormal due to lack of electrolyte and specific ions. The normal adrenal hormones, or the addition of cortisone *in vitro*, seem to render the tissue more resistant to these abnormal conditions.

It is felt that with some development of the technique and further study of the most sensitive conditions, the effects here reported might provide a method for assay and also throw light on the mechanism of action of various hormones and the extent

and concentration in which they are active in different tissues.

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Use of Deoxyribonuclease Inhibitors in the Isolation of Deoxyribonucleic Acids

In recent methods[1] for the isolation of deoxyribonucleic acids from mammalian tissues, the use of buffered (*p*H 7) solvents containing low concentrations of sodium arsenate, sodium citrate or sodium borate has been advocated in order to prevent enzymic depolymerization during the initial extraction of the deoxyribonucleohistone. As these salts are known to inhibit the action of pancreas deoxyribonuclease[2], their use in this connexion presumably rests upon the tacit assumption that the intracellular deoxypentosenucleases of mammalian tissues[3] have properties similar to those of the pancreas enzyme.

A study of the deoxypentosenucleases isolated from various animal tissues, however, shows that this assumption is not justified. Thus, the properties of the purified enzymes from, for example, calf thymus, rat liver, mouse tumour tissue and rat embryo, while closely similar among themselves, differ appreciably from those of the deoxyribonuclease of pancreas. The intracellular tissue enzymes require ions for activation, and are reversibly inactivated by dialysis against distilled water. They have optimal activity at *p*H 5·2 and are almost inactive at *p*H 7–7·5. In marked contrast to pancreas deoxyribonuclease, enzyme activity is not inhibited by sodium citrate, sodium fluoride, sodium arsenate or sodium borate. Indeed, in solutions of favourable *p*H but low ionic strength, these salts may even activate the enzymes.

The *p*H of tissue homogenates prepared in unbuffered aqueous solvents usually lies between 5·6 and 6·2, and is favourable for the action of the intracellular deoxypentosenucleases. The activity of these enzymes, however, is considerably reduced when homogenates are prepared in solvents buffered at *p*H 7–7·5. The fact that little or no depolymerization occurs when deoxyribonucleohistones are isolated in buffered citrate or arsenate solutions[1] thus appears to be due to the maintenance of a *p*H unfavourable for enzyme activity, rather than to the inhibition of the enzymes themselves.

An investigation of the nuclear and cytoplasmic fractions separated from tissue homogenates according to well-established methods[4] shows that the deoxypentosenucleases are confined to the cytoplasm of the cells, and are possibly associated with some particulate fraction (for example, mitochondria). As the intracellular substrate for the cytoplasmic deoxypentosenuclease is located entirely within the cell nucleus, it is essential in these studies of enzyme distribution to carry out all operations as rapidly as possible and to avoid undue damage to the nuclei, otherwise artefacts, due to redistribution by the combination of the enzyme with its substrate as well as by adsorption, are particularly liable to occur. It may be mentioned that the cytoplasmic enzyme is almost invariably adsorbed to a greater or less extent by the nuclei when the latter are isolated in 30 per cent sucrose[5]. In ionic solvents, adsorption of the deoxypentosenuclease is less likely to occur.

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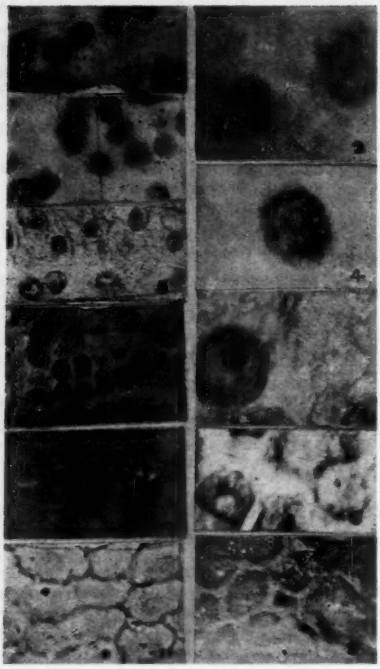
Effect of Trichloracetic Acid on Nuclear Proteins

The demonstration of the property of hot trichloracetic acid in bringing about the dissociation of nucleic acid from nucleoproteins by Schneider[1] has led many authors in recent years to use it in different cytochemical experiments[2–4]. The protein framework of the chromosomes thus liberated provides a useful substrate for several biochemical procedures. Both ribo- and deoxyribo-nucleoproteins have been found to be affected by such treatments.

It has been recently demonstrated by Kaufmann and his associates[4] that, if cells with their nuclei are treated with hot trichloracetic acid at low concentration followed by staining with Bhaduri's[5] Feulgen and light green technique, an increase in the intensity of coloration in contrast to the control results for both chromosomes and nucleoli, as a result of reaction with acid dyes. The green colour, which is strongly taken up by both the nucleoli and chromosomes in such treated materials, shows that in all probability the increase in staining effect is referable to the reaction of acid dyes with released protein. Following enzyme treatment, Kaufmann *et al.* have also indicated the presence of a histone type of protein in chromosomes and possibly tryptophane in nucleoli.

We have been studying for some time, in different plant materials, the effect of different concentrations of trichloracetic acid on both chromosomes and nucleoli, and their demonstration by staining with both acidic and basic dyes; though our results are parallel to those of Kaufmann *et al.*, they have provided additional information.

The materials for the present investigation consisted of different plant materials (*Zephyranthes*, *Allium*, etc.), where mainly the long-chromosome types have been chosen, as there the effect on the chromosome structure could be indicated precisely. The experiments, involving a series of trials in different concentrations of the acid applied for different times at different temperatures, show that while hot trichloracetic acid in low concentration brings about an increase in the intensity of staining with acidic dyes, interesting results come out if the concentration of the acid is gradually raised. The duration of treatment, too, has a marked effect.



Microphotographs showing sections of *Allium cepa* and *Zephyranthes longifolia* (control and treated in trichloracetic acid at 90° C.). Figs. 1–4, Feulgen-light green prep. of *A. cepa*: 1 and 2, general appearance in control and after 30 min. treatment in 1 *M* acid; 3 and 4, magnified view of nuclei of (1) and (2) showing difference in the intensity of nucleolar staining. Figs. 5–8, the same prep. of *Z. longifolia*: 5 and 6, general appearance in control and after 45 min. treatment in 1 *M* acid; 7 and 8, magnified view of nuclei of (5) and (6) showing difference in the intensity of nucleolar staining. Figs. 9–11, sections of *A. cepa*: 9 and 10, nuclei after treatment in 1 *M* acid for 3 hr.; 9, showing no staining of nucleolus; 10, chromosomes; 11, cells in methyl green – pyronin prep. of materials treated for 1 hr. 15 min. in 0·75 *M* acid. Figs. 3, 4, 7, 8, 10 × 1,300; remainder, × 400 approximately

Treatment of the cells with 1 *M* trichloracetic acid at 90° C. for 3 hr. can bring about a complete disintegration of nucleoli. The cells thus treated give no indication of nucleoli when stained with Feulgen and light green technique or crystal violet. The gradual loss in staining intensity can best be followed stepwise if cells are stained following treatment at 90° C. with 1 *M* trichloracetic acid for 30 min., 45 min., 1 hr., and so on, followed by thorough washing, until after about three hours (Figs. 1–9) there is complete loss of staining property.

The results therefore indicate that not only the concentration of the acid, but also the duration of treatment must be taken into consideration in accounting for the effect. The experiments have also revealed that three hours treatment in hot trichloracetic acid may not be sufficient to bring about a complete disintegration of nucleolar protein for all plant materials; hence the time of treatment may vary in different cases. It is significant that chromosome structure does not undergo disintegration in that concentration of the acid which brings about such extreme results with nucleoli (Fig. 10). In such preparations, however, the entire structure of the chromosome seems to be much reduced, due probably to the disappearance of nucleic acids from its body.

Moreover, neither the chromosomes nor the nucleoli can be stained when the methyl green – pyronin technique[6] is followed after treatments even in such low concentration of the acid as is sufficient to remove the nucleic acids without disintegrating the nucleolar protein (Fig. 11). The results thus once more confirm the theory that pyronin and methyl green are specific dyes for ribo- and deoxyribo-nucleic acids respectively. Our experiments provide no evidence as to the cause of the specificity of the methyl green – pyronin technique, which Kurnick[7] believes depends on the degree of polymerization of the two types of nucleic acids.

Our results show that hot trichloracetic acid can bring about a complete disintegration of the nucleolar protein, which is probably tryptophane as suggested by Kaufmann; but significantly has no effect on the fibrous protein of chromosomes, which is in all probability histone. Further investigation is necessary to find out the cause of the differential effect on the two types of proteins, whether it is attributable to their known chemical difference or to their physical state.

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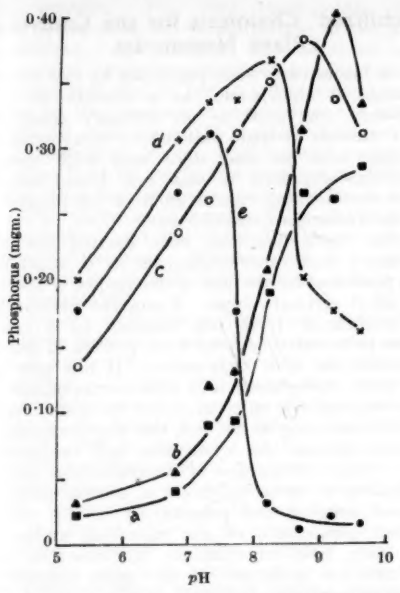
Nature of Phosphatase Activity

Cloetens[1], after a careful investigation of the reactivation of dialysed alkaline intestinal phosphatase, concluded that alkaline phosphatases in general consist of a slightly active or completely inactive part and the two ions, magnesium and zinc. The observations of Hove, Elvehjem and Hart[2], and of Thoai, Roche and Roger[3], showed the importance of certain amino-acids in restoring activity when particular inorganic ions were also present. Thus, it was evident that the dialysable prosthetic group may be a combination of compounds containing these amino-acids with a metal other than magnesium, possibly zinc. But Abul-Fadl and King[4], in their experiments on kidney alkaline phosphatase, observed that the three main factors which were important for the activity of this enzyme were a specific protein, a specific dialysable organic group or groups not of the nature of an amino-acid, and an inorganic ion, magnesium. They stated that the two-metal theory of Cloetens was highly improbable, since no evidence of the indispensability of zinc was obtained.

In my experiments, using the phosphatase of *Penicillium chrysogenum* Q-176, certain very interesting results were obtained which show that both magnesium and zinc ions are important for the activity of alkaline phosphatases. I have already shown[5] that the phosphatase in the mould is an alkaline enzyme, and



Effect of varying proportions of magnesium and zinc ions on the phosphatase activity of cyanide-inhibited enzyme at different *p*H's. Each substrate contained 0·001 *M* $MgSO_4$ with the following concentrations of $ZnSO_4$: (*a*) 0·004 *M*; (*b*) 0·002 *M*; (*c*) 0·001 *M*; (*d*) 0·0004 *M*; (*e*) nil

that it was reactivated after cyanide-inhibition when zinc was added in optimum concentrations. Calcium also inactivated the enzyme at a concentration of about 0·001 *M*. Later experiments showed that zinc ions were not easily removed even after prolonged dialysis, and the activity of the calcium-inhibited enzyme was almost completely restored by the addition of magnesium, but not of zinc. Thus, the activity appears to depend on the presence of both magnesium and zinc ions, the latter being not easily displaced by calcium ions. Magnesium, however, appears to be more loosely bound to the protein complex, so that it is easily replaced by calcium.

In attempting to explain the mechanism of activity of the enzyme at different *p*H's through which the mould passes during its growth in still cultures, experiments were carried out on the activity of the enzyme at different *p*H's using veronal-acetate buffer. The importance of the relative proportions of these magnesium and zinc ions for the activity of the enzyme is clearly brought out in the accompanying graph, which shows that while the cyanide-inhibited enzyme was restored to activity on the acid side by magnesium, the further addition of zinc at increasing concentrations shifted the *p*H of optimum activity further to the alkaline side, accompanied by a depression of activity on the acid side. This phenomenon was also associated with a decrease in activity with increase in the concentration of zinc beyond a certain range.

These observations suggest an explanation for the results of Willstätter, Waldschmidt-Leitz and Memmen[6], who reported that while impure gastric lipase was most active at *p*H 4–5, the optimum activity after purification was at about *p*H 8·0. Moreover, for animal phosphatases, uricase, arginase, etc., the *p*H for optimum activity is far removed from that of the tissues in which they are found and, contrary to expectations, they have been observed to be active. In the light of my observations, these results suggest that an enzyme having prosthetic groups may function at different *p*H's as and when required by merely varying the relative proportions of these groups.

The above phenomenon may also be related to the mechanism of action of trace elements. Such elements, though indispensable in small concentrations, often prove toxic in more than the optimum concentrations, and their toxicity can be mitigated, at least in certain instances, by an intake of some other element. I suggest that when the trace-element is entirely absent or in excess, the *p*H of optimum activity of the enzyme may shift to a point when metabolism is upset as a result of the displacement of ionic equilibrium.

Details of this work will be published elsewhere.

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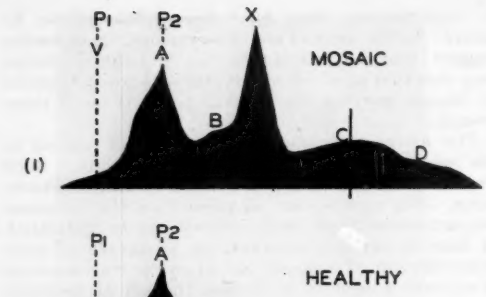
An Abnormal Protein Associated with Tobacco Mosaic Virus Infection

In virus-free extracts from mosaic tobacco leaves a protein which was not detected by Frampton and Takahashi[1] or by Wildman, Cheo and Bonner[2] has been resolved and isolated by electrophoresis.

A modification of Chibnall's ether–water method[3] was used for extracting the proteins from the leaf tissues. A special effort was made to promote the extraction of substances from the residue. The components of the ultra-centrifuged and concentrated supernatants were resolved in a Tiselius electrophoresis apparatus.

Typical scanning diagrams of extracts from mosaic (Fig. 1) and healthy (Fig. 2) Turkish tobacco leaves are shown. An odd component is found in Fig. 1 but is absent in Fig. 2. This component ***X*** comprises an appreciable proportion of the total. In this preparation the virus has been eliminated by ultra-centrifugation. The position normally occupied by the virus is marked *V*. The ***X***-component is resolvable about seven days after infection, but its concentration does not seem to increase after longer periods of infection. It was also found in similarly prepared, presumably virus-free, extracts of mosaic tomato leaves, but not in extracts of healthy leaves.

A small amount of the ***X***-component was isolated by a combination of ultracentrifugation and low-temperature *p*H alcohol technique followed by electrophoresis. This colourless fraction of ***X*** gave positive biuret, ninhydrin and Millon tests, a negative phosphorus and Molisch test and a slight reaction with orcinol.



Electrophoretic scanning diagrams of extracts from (1) mosaic, and (2) healthy Turkish tobacco leaves. Infection period, 7 days. *V*, Tobacco mosaic virus; *X*, abnormal protein; *A*, *B*, *C*, *D*, normal proteins; P_1,P_2, coloured substances. Extracts prepared from 200 gm. of fresh leaves using modified ether–water method, virus removed by ultracentrifugation, supernatant proteins concentrated with ammonium sulphate. Final dialysate volume, mosaic 17 ml., healthy 14 ml. Run made in 0·1 ionic strength cacodylate buffer, *p*H 7·0, 15 m.amp. 3 hr.

Its ultra-violet absorption maximum was 275 mμ. Electron micrographs of this *X*-substance revealed the presence of indefinite roundish aggregates.

In the extracts of healthy leaves there is evidence of at least four other components (Fig. 2). Three are negatively charged (*A*, *B*, *C*) and the fourth (*D*) positively. Component *A* was discovered earlier by Frampton and Takahashi and seems to be identical with Wildman, Cheo and Bonner's predominant protein, fraction I. Component *B* has been tentatively identified as their fraction II. Near the starting boundary there appears to be at least one slow-moving component *C*. To the right of the boundary there is a suggestion of a positively charged component *D*. In addition, there are two coloured substances. The migration fronts of these are marked P_1 and P_2.

A comparison of Figs. 1 and 2 shows roughly that Wildman, Cheo and Bonner's predominant protein, *A*, decreases with increase of virus, and that components *B*, *C* and *D* apparently do likewise.

The origin of component *X* in the diseased host and its significance in virus synthesis have yet to be explained. It is possible that it arises as a degradation product of some normal constituent of the host or is a by-product of deranged host metabolism. There is also the possibility that it is a relatively stable stage in the synthesis of the virus. If the latter can be proved to be the case, then tobacco mosaic virus does not multiply from fragments of pre-existing virus but is formed *de novo*.

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'Solubilized' Chemicals for the Control of Plant Nematodes

Work has already been published by one of us[1] on the value of chlorphenol as a nematicide. The chlorphenol was used as an ordinary solution in water; though of high toxicity to many species of eelworms, such as the stem and bulb eelworm (*Ditylenchus dipsaci*), it was not found effective against cyst-forming species such as the potato root eelworm (*Heterodera rostochiensis*).

Further work has now been carried out using chlorphenol and other chemicals in a 'solubilized' form[2], produced by the use of detergents of the long-chain alkyl sulphate type. Using the chemicals in this 'solubilized' form has resulted in a marked increase in toxicity coupled with powers of penetration which are of a high order. It has now been found that chlorphenol and allied compounds used in this way can not only penetrate the cysts of potato root eelworm lying in the soil, but also penetrate the egg-shells within the cysts and kill the enclosed larvæ. Other advantages of 'solubilization' are ease of solubility to levels in excess of normal solubility, increased wetting and penetration of the soil and increased persistence of the chemicals in the soil. Preliminary field experiments on tomatoes under glass and on potatoes in the open support our laboratory work.

It has also been found that a range of allied chemical compounds lend themselves to 'solubilization' and are also of high toxicity to eelworms. Briefly, the toxicity of chemicals we are working with is as follows. Phenols are of low toxicity, cresols are of higher toxicity and the xylenols of higher toxicity still. When these compounds are chlorinated, the position is reversed, that is, the chlorphenols are the most toxic, the chlorcresols come next and the chlorxylenols are of low toxicity. With the chlorphenols the greater the degree of chlorination the higher the toxicity and the more phytotoxic the material becomes.

The investigation is now being actively pursued, and thanks are due to the Agricultural Research Council for providing the services of a full-time chemist (Miss J. K. Bartlett) to assist in the work.

A full account of this work will appear elsewhere in due course.

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Simplified Embedding of Biological Material for Thin Sectioning

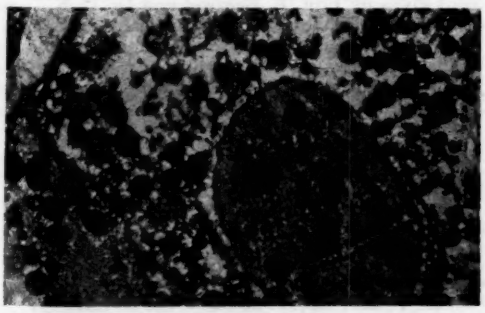
Since the introduction of thin sectioning by conventional methods for electron microscopy in 1948[1], several embedding techniques have been described[1,2]. In one of these, namely, double embedding in nitrocellulose and paraffin, the tissue is first infiltrated with an ether-alcohol solution of nitrocellulose; the volume occupied by the solvent is then filled with

molten paraffin. The chief disadvantage of this method is the slowness of infiltration of the viscous nitrocellulose. In addition, the hardness of the block cannot easily be controlled to suit the hardness of the material to be cut. The second method in common use consists in embedding the material in a plastic such as butyl methacrylate, which is then polymerized in the temperature range 50°–60° C. for 12–24 hr. to form a hard mass. We find, however, that the polymerization is difficult to control. The hardness is governed by the degree of polymerization, and the cutting qualities are quite sensitive to hardness. Furthermore, the hardness appears to increase with time, making storage of the blocks impractical.

The present technique evolved from a belief that it should be possible to simplify the embedding if the use of a solvent for the embedding material could be dispensed with. It is well known that the melting point and hardness of a beeswax–rosin mixture is a function of the beeswax–rosin ratio. A preliminary experiment with a ratio of 1 : 1 by weight gave a block with excellent cutting qualities. The melting point was rather high, however, being about 80° C., and the rosin imparted a decided opacity to the block, making it difficult to orient the tissue. A snow-white (cosmetic grade) beeswax was then obtained and mixed in a ratio of 1 : 2 with a synthetic resin (Harleco synthetic resin, Hartmann–Leddon Co., Philadelphia) used for microscope mounts. This mixture has a melting point of 68° C. and a very slight colour in the molten state. Embedding is carried out in two stages. The tissue, after thorough dehydration, is put into pure molten beeswax for half of the embedding time. The second stage consists of immersion in the beeswax–resin mixture at 70° C. The total embedding time is about two hours for slices of tissue 200 microns in thickness[3].

If section-cutting is done with a trough fixed to the microtome knife, best results are obtained with water in the trough, rather than the usual 40 per cent alcohol–water mixture, since the alcohol vapour appears to soften the embedding material in the block slightly.

Two solvents are used for extracting the embedding medium, if extraction is desired. Carbon tetrachloride will remove the beeswax, while the resin is readily soluble in benzene or toluene. Without allowing the section to dry, it is finally immersed in a 0·2 per cent collodion solution to form a film on which electron microscope screens are placed.



Beeswax–resin embedded section of rat liver; fixed with osmic acid; embedding removed. × 6,000

The method is rapid, easy to control, and has excellent cutting qualities in the 0·05 micron range. A typical micrograph is reproduced herewith.

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Effects of House Spraying on African Anophelines

THE communications of Dowling[1] and Nair[2] on interrelated subjects in the same issue of *Nature* justify the reporting of some work in course of publication and other work submitted for publication.

Table 1 compares results obtained while in Uganda with similar work of Muirhead-Thomson[3,4] in Tanganyika, using huts made to his description[5], and also wood and fibre huts fitted with entry and exit traps. The work of Muirhead-Thomson is quoted by Nair and is necessary to the interpretation of the house catches recorded by Dowling. Muirhead-Thomson's[3] dosage of 400 mgm./sq. ft. of the powder is believed to correspond to 100 mgm./sq. ft. of *p′p′* DDT. Uganda figures are totals over sixteen weeks.

Table 1

Type of hut	Dosage (mgm./sq. ft.)	Locality	Species	No. dead	No. alive	% kill
Mud	100 *p′p′* DDT	Tanganyika	*gambiæ*	11	553	2
Mud	145 " "	Uganda	*gambiæ*	24	15	62
Mud	24 γ-BHC	Tanganyika	*gambiæ*	739	0	100
Mud	27·5 γ-BHC	Uganda	*gambiæ*	51	1	98
Mud	145 *p′p′* DDT	Uganda	*funestus*	42	12	78
Mud	27·5 γ-BHC	Uganda	*funestus*	90	6	94
Fibre-board	332 *p′p′* DDT	Uganda	*gambiæ*	103	3	97
Fibre-board	35·5 γ-BHC	Uganda	*gambiæ*	66	2	97
Fibre-board	332 *p′p′* DDT	Uganda	*funestus*	203	0	100
Fibre-board	35·5 γ-BHC	Uganda	*funestus*	108	3	98

There are some further differences between the Uganda and Tanganyika results, in the ratio of fed to unfed mosquitoes, and in the numbers in the exit-traps and in the huts. The advantages claimed for the wood and fibre-board huts in this study include: (*a*) freedom from ants, which may remove dead mosquitoes; (*b*) ease of catching live adult mosquitoes; (*c*) rigid and reproducible construction of exit traps; (*d*) lack of adventitious exits other than exit traps; (*e*) general ease of working compared with primitive mud huts.

It will be seen that the differences between the kills obtained with DDT and BHC were not so great as in Muirhead-Thomson's studies.

Referring to Table 8 of the communication by Dowling, comparable results were obtained during 1948–49, over a larger number of huts and for mosquitoes including *A. funestus*, during a large-scale spraying experiment at Jinja, an account of which has been submitted for publication. Where untreated (new) huts were adjacent to treated huts, simul-

taneous night hand catches followed by simultaneous morning 'flit' catches were recorded. In Table 2 the catches are recorded for sake of brevity as total mosquitoes, but both Anophelines and Culicines were usually more numerous at night than in the morning in the treated catching station, and showed the opposite tendency in the untreated catching station. The catching took place during July–September 1948, the last spraying with 4 per cent *p'p'* DDT in dieseline having taken place in November 1947.

Table 2

	Night	Morning	Night	Morning
Hut *A* (untreated)	11	20	14	57
Hut *B* (treated)	12	0	13	2

	Night		Morn.		Night		Morn.		Night		Morn.	
Hut *C* (untreated)	3	7	21	29	14	8	13	16				
Hut *D* (treated)	1	1	15	2	7	2	7	2				

In addition, routine morning 'flit' catches at weekly or monthly intervals were made in eighteen untreated (new) houses in the treated area, in addition to catching at 108 treated catching stations. The 'female *funestus*-per-house' catches in the eighteen houses were greater than those from the 108 houses throughout the period recorded, which extended from May 1948, six months from last spraying, until June 1949.

It was concluded that the 'flitted' catching station technique (Table 7 of Dowling), which was developed before the use of persistent insecticides, for example by Hocking[6], is of doubtful value when the catching stations are treated. Further investigation would appear to be needed on the interpretation of results from untreated catching stations in a treated area, and both the measurement of mosquito prevalence and malariometry await adequate statistical treatment.

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Quantitative Determination of Amino-acids Separated by Paper Partition Chromatography

Determination of individual amino-acids in a chromatographed mixture by measuring nitrogen content was discouraged by Martin and Mittelmann[1], who reported interference from the solvents used. The method has now been re-investigated. Chromatograms were prepared using Whatman No. 1 paper and the apparatus described by Datta, Dent and Harris[2]; the solvents were (*a*) *n*-butanol-acetic acid[3], and (*b*) a mixture of phenol and water (4 : 1) in the presence of acetic acid. The papers were dried overnight at room temperature, then sprayed with Moore and Stein[4] reagent diluted with methyl alcohol to contain 0·1 gm. ninhydrin/100 ml. The colours obtained with this reagent were found to be more stable than those given by a solution of ninhydrin in *n*-butanol, and there was less vertical streaking of the spots on the paper. The papers were heated, the spots outlined with pencil and identified by comparison with a series of similarly prepared 'maps'. Demarcation of the spots is helped by the fact that adjacent spots often give slightly different colours with ninhydrin. The identified spot and a piece of paper of the same area were cut from the same sheet, the latter for a blank determination.

Each specimen was placed in a micro-Kjeldahl flask with a side-arm which could hold 3 ml., and heated for 2 min. with 0·1 *N* sodium hydroxide solution to remove any ammonia absorbed by the paper[5]. Digestion was carried out for 12 hr. with hot concentrated sulphuric acid containing a copper and selenium catalyst[6]. The digest was diluted to a known volume in the side-arm and the ammonium-nitrogen content of an aliquot determined by the Conway microdiffusion method, using 0·0002 *N* hydrochloric acid containing Tashiro's reagent as indicator.

The method was first applied to mixtures of amino-acids. The results are given in the accompanying table and show that unless the quantities of amino-acid are too large to separate well on the paper, this method of estimation is reliable.

Determination of Amino-acids in Prepared Mixtures

Amino-acids	μgm. taken	% estimated	Paper blank as % total nitrogen measured
Mixture 1. Arginine	21·3	108	18
Tyrosine	25	100	22
Tryptophan	25	128	20
Histidine	25	72	18
Mixture 2. Tryptophan	10	101	52
Histidine	10	97	56
Mixture 3. Hydroxyproline	10	109	42
Alanine	10	93	60
Lysine	10	86·5	59
Glycine	10	99	43
Aspartic acid	10	99	43

The method was also applied to a deproteinized aqueous extract of bean embryos prepared by Awapara's method[7]. It showed that when 100 μl. extract was used to prepare each of three chromatograms, the aspartic and glutamic acid contents determined on each were 7·7 μgm. aspartic acid-nitrogen and 6·8 μgm. glutamic acid–nitrogen, with exact agreement between the triplicates.

I am glad to acknowledge the help and encouragement given by Prof. E. Baldwin and Dr. C. E. Dent, and to thank Mr. J. H. Trendall for making the micro-Kjeldahl flasks used in these experiments.

This work was carried out during the tenure of a junior agricultural research fellowship given by the Agricultural Research Council.

C. Klatzkin

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Oct. 9.

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[4] Moore, S., and Stein, W. H., *J. Biol. Chem.*, **176**, 367 (1948).
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FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, March 10

UNIVERSITY OF LONDON (at Birkbeck College, Malet Street, London, W.C.1), at 8 p.m.—Prof. J. D. Bernal, F.R.S.: "Science and English Literature in the Seventeenth Century".*

Tuesday, March 11

UNIVERSITY OF LONDON (in the Hatton Lecture Theatre, Queen Mary College, Mile End Road, London, E.1), at 5 p.m.—Prof. Michael J. S. Dewar: "The Molecular Orbital Theory of Organic Chemistry" (Inaugural Lecture).*

INSTITUTION OF CHEMICAL ENGINEERS (joint meeting with the LOW TEMPERATURE GROUP of the PHYSICAL SOCIETY, at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Dr. M. Ruhemann: "The Control of Low Temperature Gas Separation Plants".

MANCHESTER GEOGRAPHICAL SOCIETY (at the Geographical Hall, 16 St. Mary's Parsonage, Manchester), at 6.30 p.m.—Prof. J. A. Steers: "The Coast of Cardigan Bay".

NORTHAMPTON POLYTECHNIC, DEPARTMENT OF APPLIED CHEMISTRY (joint meeting with the INSTITUTION OF METALLURGISTS, at St. John Street, London, E.C.1), at 7 p.m.—Mr. R. J. Brown: "The Application of High Frequency Currents to the Heat Treatment of Metals".*

ROYAL AERONAUTICAL SOCIETY (at 4 Hamilton Place, London, W.1), at 7.30 p.m.—Mr. C. H. E. Warren: "An Introduction to Supersonics".

SOCIETY OF INSTRUMENT TECHNOLOGY, NORTH-WEST SECTION (at the College of Technology, Manchester), at 7.30 p.m.—Mr. D. T. Germain-Jones: "Geophysical Surveying".

Wednesday, March 12

BRITISH PSYCHOLOGICAL SOCIETY, INDUSTRIAL SECTION (in Room 105, London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 1 p.m.—Annual General Meeting; at 1.10 p.m.—Dr. H. G. Maule: "Project Studies in Postgraduate Training, with reference to a Study of Industrial Rehabilitation".

ROYAL SANITARY INSTITUTE (at 90 Buckingham Palace Road, London, S.W.1), at 2.30 p.m.—Mr. T. C. Williams: "Various Aspects of the Rag, Flock and other Filling Materials Act, 1951".

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Mr. J. C. Wylie: "The Value of Sewage and Refuse in Promoting Food Production".

SOCIETY OF CHEMICAL INDUSTRY, FOOD GROUP (joint meeting with the LONDON SECTION of the INSTITUTE OF BREWING, at the Brewing Industry Research Foundation, Nutfield, Surrey), at 3 p.m.—Discussion on "The Chemistry of Hops".

GEOLOGICAL SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Dr. Nancy Hartshorne Kirk: "The Tectonic Structure of the 'Anticlinal Disturbance' of Breconshire and Radnorshire—Pont Faen to Presteigne".

ROYAL AERONAUTICAL SOCIETY (in the Salons de l'Hôtel des Anciens Élèves des Écoles d'Arts et Métiers, 9bis Avenue d'Iéna, Paris), at 5 p.m.—Mr. Henry Knowler: "The Future of the Flying Boat" (5th Louis Blériot Lecture). (To be read in French by M. Benoit.)

INSTITUTE OF PETROLEUM (at Manson House, 26 Portland Place, London, W.1), at 5.30 p.m.—Papers on "Alcohol Motor Fuels" (Mr. S. J. W. Pleeth: "Production and Use"; Mr. T. C. Owtram: "Economic Aspects of Alcohol in Motor Fuels".)*

MANCHESTER STATISTICAL SOCIETY (at the Reform Club, King Street, Manchester), at 5.30 p.m.—Major-General B. K. Young: "Road Accident Statistics".

UNIVERSITY OF LONDON (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Prof. R. B. Cattell: "Some Recent Quantitative Research on Personality and the Culture Pattern".*

ROYAL STATISTICAL SOCIETY, STUDY SECTION (at the E.I.M.A., 2 Savoy Hill, London, W.C.2), at 6 p.m.—Mr. D. A. Clark: "The Census of Distribution".*

UNIVERSITY OF LONDON (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 6 p.m.—Dr. J. T. Edsall: "Interactions of Proteins with Ions and Neutral Molecules".*

Thursday, March 13

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 10.30 a.m.—Discussion on "The Physics of the Liquid State" (to be opened by Prof. N. F. Mott, F.R.S.).

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. T. H. Flowers: "Electronic Telephone Exchanges".

TELEVISION SOCIETY (at University College, Gower Street, London, W.C.1), at 7 p.m.—Fleming Memorial Lecture.

CHEMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 7.30 p.m.—Scientific Papers.

BIRKBECK COLLEGE PHYSICS SOCIETY (in the large Lecture Hall, Institute of Hygiene, Keppel Street, London, W.C.1), at 8.15 p.m.—Prof. Max Born, F.R.S.: "Physical Reality".*

Friday, March 14

ASSOCIATION OF APPLIED BIOLOGISTS (joint meeting with the CROP PROTECTION PANEL of the SOCIETY OF CHEMICAL INDUSTRY, in the Mining Lecture Theatre, Imperial College of Science and Technology, Prince Consort Road, London, S.W.7), at 11 a.m.—Discussion on "Herbicides and Systemic Fungicides".*

SOCIETY OF CHEMICAL INDUSTRY, CORROSION GROUP (joint meeting with the SECTION ON PROTECTION FROM CORROSION OF THE ASSOCIATION BELGE POUR L'ÉTUDE, L'ESSAI ET L'EMPLOI DES MATERIAUX, at the Iron and Steel Institute, 4 Grosvenor Gardens, London, S.W.1), at 10 a.m.—Papers on "Protective Coatings (Metallic and Paint) under conditions of Atmospheric Corrosion".

ROYAL ASTRONOMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Scientific Papers.

INSTITUTION OF MECHANICAL ENGINEERS (at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Capt. C. G. Adams: "Basic Engineering Standards and their Place in Design".

SOCIETY OF DYERS AND COLOURISTS, MANCHESTER JUNIOR BRANCH (in the Reynolds Hall, College of Technology, Manchester), at 6.30 p.m.—Dr. A. E. Stubbs: "Progress in Textile Bleaching".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 9 p.m.—Prof. J. Read, F.R.S.: "Alchemy and Art".

Saturday, March 15

BRITISH MYCOLOGICAL SOCIETY (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 11 a.m.—Scientific Papers.

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ASSISTANT (Grade B) IN PHYSICS—The Principal, Royal Technical College, Salford (March 15).

LECTURER IN CHEMISTRY (with special reference to physical chemistry) at the Luton and South Bedfordshire College of Further Education—The Borough Education Officer, Education Office, 63–69 Guildford Street, Luton, Beds (March 15).

PASTURE RESEARCH OFFICERS (with a science degree, preferably with honours, and an aptitude for research work) IN THE DEPARTMENT OF RESEARCH AND SPECIALIST SERVICES, Southern Rhodesia—The Secretary, Southern Rhodesia Government, 429 Strand, London, W.C.2 (March 15).

SENIOR LECTURER IN ADVANCED NON-FERROUS METALLURGY to honours B.Sc. (metallurgy) standard, and a LECTURER IN MATHEMATICS for all stages of external degrees—The Registrar, College of Technology, Suffolk Street, Birmingham 1 (March 15).

SENIOR LECTURER or LECTURER IN ENGINEERING at the Nigerian College of Arts, Science and Technology—The Secretary, Advisory Committee on Colonial Colleges, 15 Victoria Street, London, S.W.1 (March 15).

ASSISTANT LECTURER IN MATHEMATICS—The Registrar, King's College, Strand, London, W.C.2 (March 22).

LECTURER IN PHYSICS, and a LECTURER IN THE DEPARTMENT OF MINING AND GEOLOGY—The Principal, Wigan and District Mining and Technical College, Wigan (March 22).

RESEARCH OFFICER (with a university honours degree in physics or in electrical engineering) IN THE DIVISION OF PHYSICS, National Standards Laboratory, University Grounds, Sydney, N.S.W., to investigate methods of improving the precision of photometric measurements, including the use of light and radiant energy detectors and the application of the results in the establishment and maintenance of photometric standards—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting No. 3773 (March 29).

ASSISTANT WATER ENGINEER IN THE WATER DEPARTMENT, Singapore—Peirce and Williams (agents to the Singapore City Council), 1 Victoria Street, London, S.W.1 (March 31).

LECTURER IN METALLURGY—The Director of Studies, Royal Naval College, Greenwich, London, S.E.10 (March 31).

LECTURER IN PURE MATHEMATICS—The Secretary to the Trustees, Magee University College, Londonderry (March 31).

LECTURER or ASSISTANT LECTURER IN THE DEPARTMENT OF BACTERIOLOGY—The Registrar, The University, Liverpool (March 31).

LECTURERS (with special qualifications in organic chemistry, or inorganic and physical chemistry) and ASSISTANT LECTURERS IN THE DEPARTMENT OF CHEMISTRY—The Secretary, The University, Edinburgh (March 31).

READER IN MARINE BIOLOGY at the University of Hong Kong—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (March 31).

RESEARCH ASSISTANT IN THE DEPARTMENT OF CHEMISTRY—The Registrar, University College, Cathays Park, Cardiff (March 31).

LEON FELLOWSHIP FOR RESEARCH (preferably in the fields of economics or education)—The Academic Registrar, University of London, Senate House, London, W.C.1 (April 1).

VETERINARY OFFICERS and RESEARCH OFFICERS in the Ministry of Agriculture and Fisheries—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting 130–173/52 (April 3).

ASSISTANT LECTURERS or LECTURERS IN BOTANY, CHEMISTRY, CIVIL ENGINEERING, MECHANICAL ENGINEERING, ANIMAL HUSBANDRY, VETERINARY ANATOMY, ECONOMICS, and ENGLISH LANGUAGE, at the University College of Khartoum—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (April 19).

SHELL RESEARCH STUDENTSHIP IN CHEMICAL ENGINEERING—The Shell Professor of Chemical Engineering, Department of Chemical Engineering, Tennis Court Road, Cambridge (April 25).

CHAIR OF GEOGRAPHY—The Registrar, The University, Manchester 13 (April 30).

CHEMICAL ENGINEER (with a first- or second-class honours degree in chemical engineering, or in chemistry with postgraduate training in chemical engineering, or equivalent qualifications) IN THE CHEMICAL DIVISION of the Rubber Research Institute of Malaya, Kuala Lumpur—The Secretary, London Advisory Committee for Rubber Research (Ceylon and Malaya), Imperial Institute, South Kensington, London, S.W.7 (April 30).

ROYAL DUTCH SHELL STUDENTSHIP IN GEOPHYSICS—The Registrar, Imperial College of Science and Technology, South Kensington, London, S.W.7 (May 31).

ASSISTANT LECTURERS IN GEOGRAPHY, GEOLOGY, and PHYSICS—The Registrar, University College, Leicester.

ASSISTANT PROFESSOR OF ANATOMY—The Dean, Faculty of Medicine, Dalhousie University, Halifax, Nova Scotia, Canada.

ASSISTANT TECHNICAL SECRETARY (a university degree, or equivalent qualification, in physics or metallurgy, and administrative ability essential) in London by the Metallurgy Division, to administer technical committees dealing with metal physics and the development of techniques for application to the iron and steel industry—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1, endorsed 'Metallurgy Division'.

CHEMISTS (Principal Scientific Officer or Senior Scientific Officer grade) at the Royal Aircraft Establishment, Farnborough, to work on problems connected with the selection, storage and combustion of fuels used in guided weapons—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting F.112/52A.

CHEMISTS and CHEMICAL ENGINEERS (Experimental Officer grade) at a Ministry of Supply Research and Development Establishment in Essex: PHYSICAL CHEMISTS (Ref. F.103/52A) with experience in physical testing methods, particularly as applied to plastics, rubber, clays, etc., (Ref. F.104/52A) with experience of the processing of plastics, particularly by extrusion, (Ref. F.105/52A) preferably with experience of combustion work, calorimetry and the measurement of transient pressures, (Ref. F.106/52A) for work on sensitiveness of initiators; ORGANIC CHEMISTS (Ref. F.107/52A) with laboratory experience and an analytical and/or research bias; CHEMICAL ENGINEERS (Ref. F.108/52A) with experience in plant development and design—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting the appropriate Ref. No.

CIVIL ENGINEERS (Main grade) (Ref. E.251/51A) and ASSISTANT CIVIL ENGINEERS (Recruitment grade) (Ref. E.252/51A) in the Air Ministry Directorate General of Works in London and the Provinces—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting the appropriate Ref. No.

GRADUATE CHEMIST (with B.Sc. or equivalent) as BIOCHEMIST IN THE RESEARCH DEPARTMENT—The Director of Research (Applications/26), Barrow Hospital, Barrow Gurney, Bristol.

GRADUATE PHYSICAL CHEMIST or METALLURGIST to study the physical chemistry of iron and steel making processes—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1.

LECTURER IN METALLURGY—The Registrar, Cumberland Technical College, Park Lane, Workington, Cumberland.

LECTURER IN TELECOMMUNICATIONS ENGINEERING—The Clerk, Northern Polytechnic, Holloway, London, N.7.

MECHANICAL/ELECTRICAL ENGINEERS (new construction) in the Sudan—The Sudan Agent in London, Wellington House, Buckingham Gate, London, S.W.1, quoting 'Mechanical/Electrical Engineer, 4/1813'.

MEDICAL RESEARCH OFFICERS (2) IN THE VIRUS RESEARCH INSTITUTE, Lagos, Nigeria—The Under-Secretary of State, Colonial Office (Research Department), Sanctuary Buildings, Great Smith Street, London, S.W.1.

METALLURGISTS (Experimental Officer grade) (with a degree in metallurgy and specialized in mineral dressing of non-ferrous ores) in the Atomic Energy Division of the Ministry of Supply in London—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting F.121/52A.

OFFICER-IN-CHARGE, Camden Park Experimental Station (Agricultural), St. Vincent, Windward Islands (candidates must have a sound knowledge of statistical technique in experimental work and be able to undertake the general administration of the station, carry out a detailed programme of plant breeding and experimental work, train agricultural apprentices, etc.)—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M.23443G.

PHYSICISTS at a Ministry of Supply Research Establishment in Cambridgeshire: SENIOR SCIENTIFIC OFFICERS (Ref. A.51/52A) with some engineering or metallurgical experience for investigations of a fundamental nature relating to armour penetration problems, (Ref. A.52/52A) with mathematical ability and some knowledge of thermodynamics for work on the mechanism of damage by small calibre shell; SCIENTIFIC OFFICERS (Ref. A.53/52A) with experience of electronics for work in connexion with high-speed photography—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting the appropriate Ref. No.

RESEARCH GRANT for research into the determination of the molecular weight and shape of high polymers in solution—Dr. P. Johnson, Department of Colloid Science, Free School Lane, Cambridge.

SCHOLARSHIPS in Austria, Belgium, Brazil, Denmark, Finland, France, Germany, Italy, the Netherlands, Norway, Persia, Portugal, Spain, Sweden and Switzerland—The British Council, 65 Davies Street, London, W.1.

SENIOR EXECUTIVE ENGINEER, Public Works Department, North Borneo—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting 27322/230.

SENIOR EXPERIMENTAL OFFICERS (one at Ministry of Supply headquarters and the other at an Establishment near London) to assist the officers in charge of administration in connexion with the recruitment and deployment of scientific and technical staff for Research and Development Establishments—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting A.76/52A.

SENIOR LECTURER (with good honours and research degrees, and industrial experience) IN INORGANIC CHEMISTRY—The Registrar, College of Technology, Unity Street, Bristol 1.

SENIOR SCIENTIFIC OFFICER to be responsible to the Director of Research for the supervision of researches relating to the metallurgy of the steelmaking and welding processes and to the mechanism of solidification of steel castings, a SCIENTIFIC AND TECHNICAL OFFICER (Metallurgist, graduate or A.I.M.) for research and development work relating to the physical and mechanical properties of carbon and alloy steel castings, a SCIENTIFIC AND TECHNICAL OFFICER (Mechanical Engineer, preferably graduate or A.M.I.Mech.E.) for development work in relation to steel foundry plant, a SENIOR TECHNICAL ASSISTANT (Metallurgist, preferably graduate or A.I.M.) for research in relation to steelmaking processes for steel castings production, and a SENIOR TECHNICAL ASSISTANT (graduate Metallurgist, preferably with knowledge of French and German) as Assistant Information Officer—The Secretary, Research and Development Division, British Steel Founders' Association, Broomsgrove Lodge, Sheffield 10.

TELECOMMUNICATIONS ENGINEERS, Gold Coast (Ref. 27325/25), and an ELECTRICAL ENGINEER, Nyasaland (Ref. 27326/50)—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting the appropriate Ref. No.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Department of Scientific and Industrial Research. Report of the Building Research Board with the Report of the Director of Building Research for the Year 1950. Pp. iv+68+20 plates. (London: H.M. Stationery Office, 1951.) 4s. net. [1112

Philosophical Transactions of the Royal Society of London. Series A: Mathematical and Physical Sciences. No. 879, Vol. 244: Under-Water Explosion Measurements from Small Charges at Short Ranges. By A. H. Bebb. Pp. 153–175. 5s. 6d. No. 880, Vol. 244: The Mechanical Behaviour of Single Crystals of certain Face-centred Cubic Metals. By E. N. da C. Andrade and C. Henderson. Pp. 177–203. 8s. 6d. (London: Cambridge University Press, 1951.) [1112

Philosophical Transactions of the Royal Society of London. Series B: Biological Sciences. No. 630, Vol. 235: The Basic Proteins of Cell Nuclei. By E. Stedman and Ellen Stedman. Pp. 565–595. (London: Cambridge University Press, 1951.) 8s. 6d. [1112

Aquinas Society of London. Aquinas Paper No. 18: The Meaning of Existentialism. By Dr. D. J. B. Hawkins. Pp. 18. (London: Blackfriars Publications, 1951.) 1s. 6d. [1212

Philips in the Service of Industry. Pp. 32. (London: Philips Electrical, Ltd., 1951.) [1212

The Bowater Papers. No. 2, 1951. Pp. 64. (London: Bowater Paper Corporation, Ltd., 1951.) [1212

Deterioration of Structures of Timber, Metal and Concrete exposed to the Action of Sea-Water. Nineteenth Report of the Committee of the Institution of Civil Engineers: Being a General Summary of the Experimental Work carried out to date on Timber. By J. Bryan. Second edition. Pp. iv+54. (London: Institution of Civil Engineers, 1951.) 5s. net. [1212

Other Countries

Report of the King Institute of Preventive Medicine, Guindy, for the Period from 1st April 1949 to 31st March 1950, by Dr. Y. S. Narayana Rao; and Report of the Government Analyst, Madras, by Sri S. Narayana Ayyar. Pp. 117. (Madras; Government Press, 1951.) 2.8 rupees. [1112

Bulletin of the American Museum of Natural History. Vol. 97, Article 5: A Study of Asiatic Larks. By Charles Vaurie. (Notes from the Walter Koelz Collections, No. 11.) Pp. 431–526+plate 17. 1.25 dollars. Vol. 98, Article 1: Studies on the Structure of the Fish School. By C. M. Breder, Jr. Pp. 28+4 plates. 50 cents. (New York: American Museum of Natural History, 1951.) [1112

Canada: Department of Mines and Technical Surveys. Geological Survey of Canada Bulletin 17: Gastropoda and Conularida of the Ottawa Formation of the Ottawa–St. Lawrence Lowland. By Alice E. Wilson. Pp. v+149 (19 plates.) (Ottawa: King's Printer, 1951.) 75 cents. [1112

Carnegie Institution of Washington. Publication 592: Contributions to Embryology, Vol. 34, Nos. 222–230. Pp. iii+196+58 plates. (Washington, D.C.: Carnegie Institution, 1951.) 8.75 dollars. [1112

B.A.N.Z. Antarctic Research Expedition, 1929–1931. Reports, Series B (Zoology and Botany), Vol. 1, Part 3: Cephalodiscus. By Dr. T. Harvey Johnston and Nancy G. Muirhead. Pp. 89–120+3 plates. (Adelaide: Barr Smith Library, The University, 1951.) 10s. [1112

Enka and Breda Rayon Revue No. 4: Selection of Articles from the 1950 Volume of *Rayon Revue*. Pp. 108. (Arnhem: International Rayon Trading Co., 1951.) [1212

Western Australia: Department of Mines. Mineral Resources of Western Australia, Bulletin No. 5: Moulding Sands. By Dr. K. R. Miles and H. A. Stephens. Pp. 98+xi. (Perth: Government Printer, 1950.) [1212

Uganda Protectorate. Annual Report of the Forest Department for the Year ended 31st December 1950. Pp. iv+51. (Entebbe: Government Printer, 1951.) 3s. [1312

National Multiple Sclerosis Society. First Annual Report for the Period of October 1946–July 1951. Pp. iii+27. (New York: National Multiple Sclerosis Society, 1951.) [1312

Catalogues

News from Sunvic. Vol. 1, No. 1, December. Pp. 4. (London: Sunvic Controls, Ltd., 1951.)

Catalogo de Libros de Cirugia. Pp. 36. Catalogo de Libros de Medicina. Pp. 32. (Madrid: Libreria Enrique Casas Gaspar, 1951.)

Particle Size Analysis with the Bound Brook Photosedimentometer. Pp. 44+8 plates. (Lichfield, Staffs.: Bound Brook Bearings (G.B.), Ltd., 1951.)

Laboratory Glassware and Thermometers. Pp. 32. (Pontypridd: H. J. Elliott, Ltd., 1951.)

Laboratory Apparatus for the Examination of Milk and Milk Products. (Catalogue P.1823.) Pp. 32. (Alperton and Birmingham: W. and J. George and Becker, Ltd., 1951.)